UNIVERSITY OF ALBERTA

MATHEMATICS TEACHERS' MEANING FOR THE PHRASE 'TEACHING TO THE MIDDLE'

BY

SUSAN RATTI ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of MASTER OF EDUCATION.

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ABSTRACT

In this study, I explored the meaning that six mathematics teachers, who claim to 'teach to the middle', have for the phrase. Data for this qualitative case study was collected in two stages: survey and interviews. Six teachers, who professed to 'teaching to the middle', volunteered to be interviewed. Prior to their interviews, these teachers completed a questionnaire that I hoped this process would orient the teachers' thinking towards their professed beliefs, and predispose them to reflect upon their teaching activities. The data from the interviews is presented in separate chapters that develop the case of each teacher. It became apparent that among these teachers two distinct meanings, (one with a focus on teaching, the other with its focus on learning), exist for 'teaching to the middle'. The teachers create a space (a middle ground) in which to work that they find efficacious. Implications relating to this teaching practice include: the formative power of statistics in mathematics teaching; pedagogic challenges facing teachers; the impact upon students and their achievement, and teachers' informal and formal assessments techniques.

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CHAPTER I

The Problem

Introduction

Over the years, I have noticed a strange phenomenon: a phrase may be uttered many times before it is brought to the attention of, and resonates with, the person hearing it. It seems as if the phrase, once uttered, is ingested with many other signals sent to and received by the brain. Some signals receive conscious attention while others are sublimated. Such was the case with a phrase I had often heard, but which had not attracted my attention until one evening in October 2000

> *I was attending a parent-teacher conference with my son's mathematics teacher. The meeting was nearing its conclusion, and we both rose from our chairs. As I shook his hand, the teacher began to describe the difficulties he was experiencing while teaching mathematics at the junior high level, in particular, in grade nine. Smiling ruefully, he said,*
>
> *"What else can I do? I have such a wide range of students in that class, it's impossible to get to them all, so I just* teach to the middle, *and hope every one gets something."*
>
> *As I heard his words and read his face, I realized that this teacher expected that I would understand both his predicament and his solution. Our handshake released, we both smiled and while he turned to greet another parent, I moved towards the exit.*

It was in the moment that the phrase 'teach to the middle', suddenly registered and resonated with me. I felt an initial physical reaction to his words: a sudden jolt in my stomach and a feeling of light-headedness, such as I have experienced before when my mind has been taken by surprise. That evening, as I walked away from the teacher's desk, I felt sure that the phrase resonated with my own experiences, both as a teacher and a student, but I could not immediately identify in which ways. I knew I had heard the phrase before, but it had not previously permeated my consciousness, it was left unattended. On this occasion, I experienced a shift of attention that focused my thoughts upon the phrase. I began to wonder what this teacher had meant when he said he 'taught to the middle', and what meaning other teachers, who claimed to teach mathematics this way might have for the phrase.

This teacher's comment aroused my curiosity and interest and I was prompted to begin listening for the phrase. I began to inquire informally about its possible meaning from colleagues, with whom I was a participant in a university course.

> *I heard the expression 'teach to the middle' the other day - I wonder whether it is one you are familiar with?*
>
> *Tom: Teach to the middle? That's what I do all the time. I have the best students and the worst. I can't get to them all, so I just aim for the middle. What else would I do? ...*
>
> *Debra: Oh, I don't think I know any one who'd admit to teaching to the middle.*

These two responses, both from high school teachers, are quite different. The first teacher confidently claims to 'teach to the middle'; he has made a decision to teach this way as a solution to the problems of addressing the needs of a diverse student body within his class, within the time he has available. The second teacher indicates that she thinks 'teaching to the middle' is something that the teachers whom she knows would be embarrassed to admit, and it is certainly not something she claims for herself.

Maureen: I think we're a lot better at meeting the needs of students in elementary schools than they are in junior high or high schools. We modify our programs much more than they do. But, yes, I'd say that you'd see 'teach to the middle' here, too."

Although this elementary school teacher did not claim to 'teach to the middle', she recognized and demonstrated an understanding for the phrase. This teacher also indicated that 'teaching to the middle' is connected to a teacher's need to meet the needs of a wide variety of students within her class. I believe her suggestion that 'teaching to the middle' is not a common phenomenon in elementary schools may be related to the various teaching approaches used by teachers at different levels of schooling. Underhill (1988) suggested that there is a progression of beliefs associated with the approaches to teaching mathematics found in elementary, junior high and senior high school, which corresponds to a general movement away from constructivist approaches in elementary schools and towards formalist, traditional approaches in high schools. If the constructivist approach presents more opportunities for meeting the needs of diverse student groups, then I could consider 'teach to the middle' in contrast to 'teach to the individual'. The elementary school teacher's perception of these differing approaches found in elementary and senior high schools may give an insight into the disparity in the response from the elementary and high school teachers regarding 'teaching to the middle'.

Over the next few weeks I began to listen for the phrase to occur when I had not introduced it. It was not long before I was attending a seminar and heard a visiting researcher use the phrase during his introduction.

At a mathematics education seminar at the University of Alberta, the presenter looked around the classroom at his audience. Seated in front of him were professors emeriti, professors, graduate and undergraduate students, from a variety of educational institutions. The research he would be discussing was built upon the groundbreaking work of one of his audience. His eyes swept the room; he asked who was familiar with the research upon which his talk would be based. Those who did not know the work remained silent, looking around the room for others in their predicament, while others, to whom the work was evidently familiar, smiled, nodded or glanced down at the floor.

`"I'm not sure how familiar you all are with Tom Kieren's work and the model he has developed with Susan Pirie. Some of you know this model very well, but others I'm not sure about. I think what I'll do is shoot for the middle and try not to bore some of you or leave others too far behind."

Unfamiliar with the prior knowledge level of his audience, this presenter decided to 'shoot for the middle', and I immediately wondered about the relationship of this phrase to 'teach to the middle'. Recognizing his audience would have widely differing

familiarity with the model he would refer to during his presentation, he chose to pitch his talk somewhere in the middle, so that those who were familiar with the research would not be bored, while those to whom this work was new, would be able to follow the description of the presenter's new research. As someone to whom this work was new, I was able to comprehend the presenter's research, in light of the Pirie/Kieren model (Pirie & Kieren, 1994). I wondered how those, to whom this model was well known, were responding to the presentation and whether the 'mixed audience' had reduced their opportunity to learn, in depth, about the presenter's research. When the presenter used the phrase 'shoot for the middle', it had meaning for him, and he was able to adapt his talk to meet his perception of the needs of the group. How, I asked myself, did the presenter understand and determine the 'middle' in the context of intention to 'shoot for the middle'?

Over many years I have frequently heard the phrase 'teach to the middle' in Canada, Great Britain and the United States. Sometimes the phrase has been spoken quietly, even secretly. On other occasions, it has been proclaimed and defended. Some teachers have excused 'teaching to the middle' and wished they could do otherwise. Others have indicated that for them this approach is an acceptable way to teach, which meets their objectives. However a search of educational writings and research has revealed that the phenomenon of 'teaching to the middle' has not been investigated. The personal interactions related above, along with my own reaction to the phase and its use, have prompted me to try to discover what it is that mathematics teachers, in particular, mean when they claim to teach this way.

Purpose of this Study

"We need to know more about teachers' lives" (Goodson, 1989a, p.138).

Teaching is a complex activity and today teachers need to teach students with a wide range of abilities, a broad range of mathematics topics (National Council of Teachers of Mathematics, 1989). The challenge to mathematics teachers is to meet their students needs in a time of mathematics education reform As the reforms unfold, professional development affords teachers opportunities to investigate new approaches to teaching mathematics (Judah, 1999). Although it is difficult to say what teachers take away from these sessions and use in their daily practice, and why some approaches are adopted while others are rejected (Ball, 1996), ultimately many teachers find their own, often idiosyncratic, individual style, reflecting a personal practical theory of teaching and learning (Ball 1996; Cornett, Chase, Miller, Schrock, Bennett, Goins & Hammond, 1992). Of the many choices open to them, some teachers choose to teach in a manner that they call 'teaching to the middle'. This study will uncover the layers of meaning that mathematics teachers, who claim to 'teach to the middle' have for the phrase, revealing an aspect of these teachers' lives, and affording them a voice in the growing body of work relating to their understanding of their work (Hargreaves, 1996, 1984).

Insights from the Phrase

As I started to consider ways in which to investigate the 'teaching to the middle' phenomenon, I decided to begin by interrogating the phrase itself, to see

whether I could glean any insights and direction for my work. I approached the phrase by delving into each of its major components: 'teach' and 'middle'.

On Teaching

> As the school year nears its end, I always ask myself: What have we who teach been doing since the beginning of the school year? Teaching is something that has been done in a school classroom, of course. But beyond that, what is it? (Jacobs, 1991, p. 122)

This study will make no attempt to answer Leland Jacobs' question. However, it cannot be ignored. It must be considered because 'teaching' is one important component in the expression 'teach to the middle'. The way in which teachers, who claim to teach this way, understand and interpret 'teach' will be related to the understanding they have for the phrase.

Dictionaries suggest that teaching is many activities, in particular 'instructing', which encompasses tutoring, coaching, ordering, training, advising, directing, and commanding. Synonyms for 'teaching' include enlightening, edifying, informing, inculcating, infusing, instilling, imbuing, indoctrinating, disseminating, and convincing (www.dictionary.oed.com). The prefixes associated with many of these words imbue them with the notion of the transfer of knowledge from one place or person to another, and exemplify the dominance of the conduit metaphor (Reddy 1979) within our language when we talk about teaching. Etymologically, the verb 'teach' comes from the old English "tacn .... OHG. [Old High German] "zeihhan, TOKEN , from an ablaut series teik-, taik-, tik- to show" and from the Greek 'teiknynai' – to show (www.dictionary.oed.com). This disjointed list suggests transfer of knowledge by telling and showing but fails to capture the reality of the lived experience of teaching.

My personal experience of teaching mathematics in a variety of different settings has revealed that there are many approaches to mathematics teaching. Researchers have attempted to encapsulate teaching practices under labels such as 'Active Teaching' (Good, Grouws & Ebmeier, 1983), 'Cognitively Guided Instruction' (Fennema, Carpenter & Peterson, 1989), 'Constructivism', or 'Inquiry Learning'. Teachers, who define their practices in terms of 'Active Teaching' (Good, Douglas & Ebmeier, 1983), align themselves with efficient classroom practices, which are based upon the study of effective teachers. In this scenario, teachers follow daily, weekly and monthly plans, which prescribe times for review, mental arithmetic, teacher presentations, individual student work, homework and testing. Others, who indicate their teaching practices follow the research into 'Cognitively Guided Teaching and Learning (Fennema, Carpenter & Peterson, 1989) have an expectation that their teaching decisions and actions will emerge from studying their students as they learn and result in students learning with meaning and understanding. Much research has been undertaken and subsequent advice given to teachers who chose to make problem-solving the main focus of their students' learning in mathematics (Cobb, Wood & Yackel, 1990; Schoenfeld, 1992). A constructivist approach to teaching and learning recognizes that teaching is about creating activities that will nurture students' individual, mental constructions and reflects a set of beliefs about knowledge and knowing. Teachers "organiz[e] information around conceptual

clusters of problems … as opposed to facts in isolation" (Sprague & Dede, 1999), and encourage student inquiry by asking thoughtful, open-ended questions with no one correct answer.

Research of these types has endeavoured to show teachers that certain classroom practices improve students' learning experiences and achievement. Advice about the many different approaches to teaching mathematics has been accompanied by appeals to reform traditional classroom practices in line with progressive, contemporary or reformed approaches. Furthermore, other researchers have observed and recorded examples of teachers' practices as they researched the relationship between such factors as teacher beliefs and practices (Thompson, 1984; Cooney, 1985), beliefs and student performance (Garafalo & Lester, 1985), and the practices of effective and exemplary mathematics teachers (Simmt, 1999; Tobin & Fraser, 1989). Ball (1996) points out that teachers often selectively choose parts of many different suggestions for effective teaching and blend them into their own personal theories to arrive at individual, often highly idiosyncratic, teaching practices. The suggestions for teaching mathematics are many; only a few have been outlined here to given an example of the breadth and depth of choice facing teachers today. It quickly becomes clear that we can have little understanding of the meaning teachers have for the word 'teach', when we hear them utter the phrase 'teach to the middle'.

On 'Middle'

A second component in the expression is 'middle'. Dictionaries indicate that 'middle' means being at neither the beginning nor the end of a series, central, equal distance from both extremes, having the same number of members on each side of it (www.dictionary.oed.com). Synonyms for middle include mean, average, centre-most, median, midst, medial, central, halfway (www.dictionary.oed.com). Etymologically, 'middle' is derived from Latin and Greek word, 'medius' and mesos'; both mean 'middle' or 'half'. One of the most remarkable connotations with 'middle' is its association with the terms 'mean' and 'average'.

Average is an interesting synonym for 'middle', since it is accompanied by its synonym, 'norm'. Since we have brought children into schools to be educated en-mass, rather than individually or in small groups at home, curricula, teaching methods and testing have been directed towards a normal or average child (Davis, Sumara & Luce-Kapler, 2000). The underlying assumption is one of normality – of the average student, of expected development within a given time frame. For in order for students to be deemed average or in the middle, there first have to be assumptions about what a normal child might be able to learn and at what rate. Conversely, there are assumptions about what might be true for 'abnormal' children, whether they are above or below the 'normal', or middle, range.

Today, standardized testing has become an important focus for mathematics education in many countries. In Alberta, students write achievement tests at the end of grade 3, 6 and 9 in mathematics, and diploma examinations in grade 12. In each of these assessments, students are graded as having achieved an acceptable standard, a standard of excellence, or having failed to meet the acceptable standard. The "Assessment Standards Document for Pure Mathematics 10" advises teachers that weightings of 75-80% and 20-25% should be given to knowledge, skills, and

understanding, at the acceptable standard and the standard of excellence respectively (Alberta Learning, 2000). Further on in this document (Appendix A) there are descriptions of acceptable student performance within each strand at each level of achievement. The results of the grade 12 diploma examination in mathematics for the school year 1999/2000 show that a little less than 74.75% of students who wrote the exam, achieved the acceptable standard, with just over 19.9% reaching the standard of excellence; almost 25% failed to reach the acceptable standard (http://www.learning.gov.ab.ca/k_12/testing/results_2000/results_toc.asp).

Clearly, assessing students by interpreting their achievements according to a normal distribution, or "nearness to the mathematically determined average value" (Davis, Sumara, & Luce-Kapler, 2000) is very important in Alberta. The labels of 'standard', typical' 'grade-level' and 'average', as well as those which are their antithesis, are an integral part of this way of thinking.

Like 'teach' whose dictionary meanings provided a diversity of suggestions for the 'doing' of teaching, while failing to capture the essences of the activity, the definitions of 'middle' keep our attention in a central place or range, yet present a multiplicity of meanings. When I hear the word 'middle' used in the phrase 'teach to the middle', questions immediately spring to mind:
In what sense is the word 'middle' being used and to what does it refer?

- Students who are of middle ability or achievement?
- A middle ground in terms of subject content or difficulty (not too hard, not too easy) ?
- A way of teaching that is adapted to fit the concept of 'passing' the class or the grade?
- A standard predetermined by the resources (the textbook, for example) chosen by the teacher or the school?
- Is 'middle' used to refer to teachers' pedagogic skills or subject knowledge?

Of course, the word may be used in reference to a combination of these, or none at all. The use of the word 'middle' in the phrase 'teach to the middle' is open to many interpretations; a person hearing the phrase can have little understanding of its meaning when the phrase is spoken.

An examination of the dominant words in the expression 'teach to the middle' has revealed the potential complexity of meaning of the phrase 'teach to the middle'. Equally, this discussion has been an examination of the components as I interpret them rather than by examining the stories of those who claim to teach this way. As I proceeded with my investigation, I heard and interpreted mathematics teachers' stories of 'teaching to the middle', and present their meaning for the phrase.

The Research Question

This focus of this study is to uncover the meaning that mathematics teachers in Alberta, who claim to 'teach to the middle', have for the phrase. In pursuing this goal, I seek to answer questions regarding teachers' use of the words 'teach' and 'middle' when they say that they 'teach to the middle', and to uncover:

> What mathematics teachers mean when they say that they 'teach to the middle'.

A set of sub-questions will guide the study:

How do teachers who 'teach to the middle' describe their teaching?
How do teachers understand 'middle' in reference to 'teaching to the middle'?
What are these teachers' attitudes towards and beliefs or assumptions about mathematics, it's teaching and learning, and how do these relate to the teachers' understanding of the phrase 'teach to the middle'?
What are the characteristics of teachers who 'teach to the middle'?

Alberta's School Mathematics Context

At this stage I think it is important to situate this research within the Alberta context. The following paragraphs describe the school mathematics context in which Alberta's mathematics teachers work.

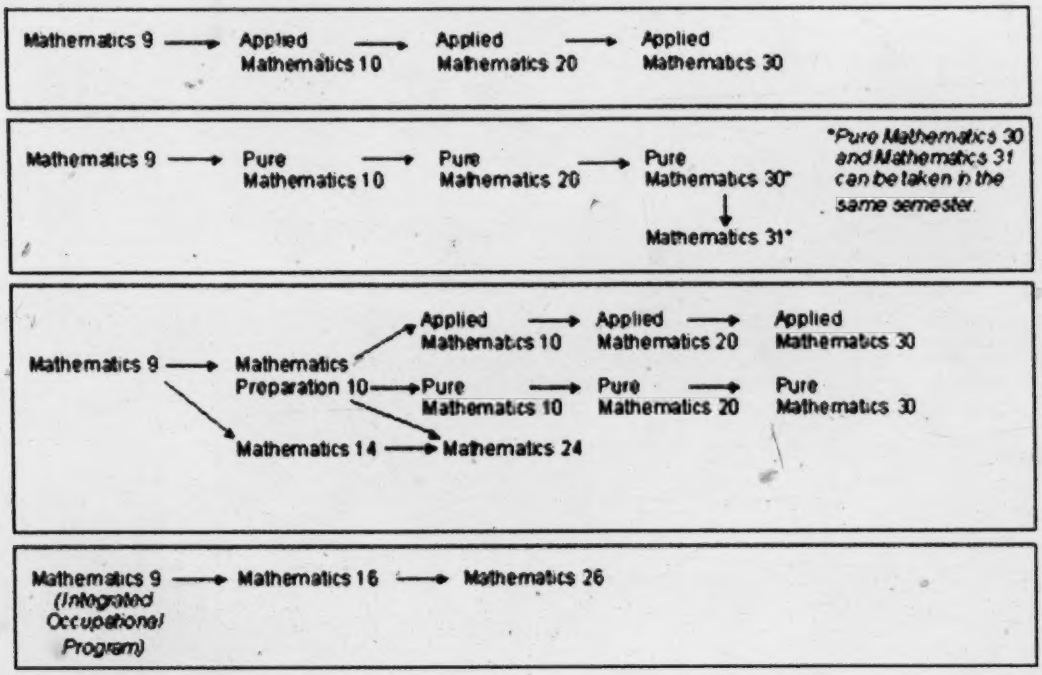
The curriculum.

Mathematics is a compulsory subject from kindergarten to grade eleven (grade twelve for those wishing to pursue tertiary education or training) in Alberta schools, with a provincially mandated program of studies or curriculum (http://www.learning.gov.ab.ca/k_12/curriculum/bySubject/math/). The curriculum documents have been rewritten within the last decade. Implementation for the new programs was: 1996 for grade 7-9; 1997 for K – grade 6; 1998-2000 for Pure and Applied Math (grade 10-12); 1995 for Math 31 (grade 12), and 1992 for the Integrated Occupational Program (IOP), a math course for students who have experienced difficulty learning mathematics.

Elementary and junior high school (kindergarten to grade nine) students usually receive mathematics instruction in heterogeneous, integrated classrooms. Students identified as stronger in mathematics may receive instruction in an accelerated mathematics class, in some schools. In grades eight and nine, IOP mathematics is offered.

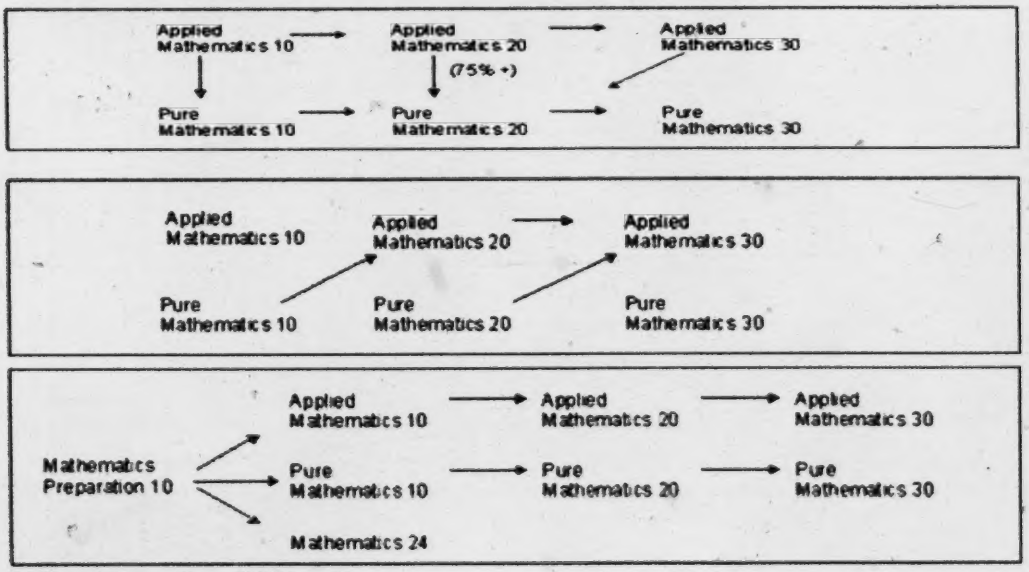
In high school, students are streamed into mathematics courses according to their achievement in grade nine mathematics. From 1989 until recently, students were placed in: Math10, 20, 30 (an academic program); Math 13, 23, 33 (a general program); Math 14, 24 (a non-academic program) or Math 16, 26 (IOMP – for those who have difficulty learning). A further mathematics course, Math 31, is available for students "who would benefit from taking a course in calculus" and "who have met or exceeded the basic entry requirements for most university or university transfer programs" (Alberta Learning, 1995, p.2). The Math 10, 20, 30 and Math 13, 23, 33 programs were phrased out by the end of the 2000/2001 school year. They were replaced by two new programs - Pure Math 10, 20, 30 which emphasizes the specialized language of algebra as the preferred method for learning mathematical concepts and for solving problems and Applied Math 10, 20 30, which focuses on the application of mathematics in problem solving (Alberta Learning, 2002, p.3). A Math 10 Preparation program was also introduced, for students who did not pass junior high school mathematics and do not have the necessary prerequisite skills and knowledge for either the Pure or Applied Math programs (Alberta Learning, 2002, p.6). The relationship and transferability among the high school mathematics programs is outlined in the two tables on the following page. Some high schools additionally offer the International Baccalaureate program and/or opportunities to prepare for Advanced Placement examinations in mathematics.

Table 1: *Program options for students entering high school*



(Alberta Learning, 2002, p.5)

Table 2: *Transfer Points between Pure and Applied Mathematics*



(Alberta Learning, 2002, p.5)

Advancement criteria

In elementary and junior high schools, students usually advance with their peer groups from year to year. Some students, who are experiencing difficulty learning mathematics, will progress by working to their own personalized learning plan. A number of schools offer 'gifted' or excellence' mathematics classes for students who appear to be working at a higher level than their peers, although there is no provincial expectation that this will occur. At the high school level, schools often require students to achieve a mark of 65% in order to advance to the next stage (year) of their program, although course marks of 50 - 79% are deemed to be 'acceptable', by the provincial achievement standards.

Provincial testing

At the end of grade three, six and nine, students write an achievement test in mathematics with the intention of

- determin[ing] if students are learning what they are expected to learn
- report[ing] to Albertans how well students have achieved provincial standards at given points in their schooling
- assist[ing] schools, jurisdictions and the province in monitoring and improving student learning (www.learning.gov.ab.ca/k_12/testing/results_2000)

In high school, students are required to write Diploma examinations at the end of the three sequential math courses (10, 20 & 30) in Pure Math or Applied Math. These examinations, mandated by the Alberta government in 1984,

were established for three main purposes:

- to certify the level of individual student achievement in selected grade 12 courses
- to ensure that province-wide standards of achievement are maintained
- to report individual and group results.

(http://www.learning.gov.ab.ca/k_12/testing/achievement/ach_gib/sec1a_purpose.asp)

The final mark a student receives in the Pure Math or the Applied Math course is composite of a school mark and an examination mark.

For the achievement test and the diploma examination, students are said to meet the 'acceptable standard' is they achieve a mark of at least 50%. The province expects that 85% of students will meet this standard. It is expected that the 'standard of excellence' will be attained by about 15% of the students and usually indicates they have received a mark in excess of 85%. High school mathematics teachers have requested and received standards documents, which highlight the differences between the 'acceptable standard' and the 'standard of excellence' (Alberta Learning, 2000). There are no such exemplars for junior high school teachers.

The Structure of the Report

The purpose of this study is to develop an understanding and interpretation of teachers' meaning for the phrase they use to describe their teaching: 'teach to the middle'. I have followed Stake's (1995) suggestions for the format of this report. The chapter following is a review of the literature that informed my understanding of 'teaching to the middle'. Subsequently, I outline my use of qualitative case study for

my research method. Then, in a separate chapter for each teacher, I present the collected data, developing a case for each teacher. Because of the qualitative nature of this study, I chose to summarize the study in a discussion chapter that follows these six chapters, rather than in the final chapter, as is often the case. The discussion chapter frames my interpretations, which may be found in the final chapter, along with suggestions for further research.

CHAPTER II

Review of the Literature

Introduction

A search of educational research and writing revealed that little has been written about 'teaching to the middle'. When the phrase has appeared, it has not been the focus of an investigation, but has been of peripheral interest in the research. In this chapter I review the literature that has made reference to 'teaching to the middle', then continue with a review of the literature that I believe directly informs my study of 'teaching to the middle'. In particular, I include a definition of teaching practice, a review of the literature relating to the influences and constraints that act upon teachers as they make teaching decisions, and slogans and labels. Finally, I examine the use of metaphor as a way of interpreting teachers' stories.

'Teaching to the Middle'

The phrase 'teaching to the middle' seldom occurs in educational writing and research. Where the phrase is used it is mentioned in passing: a short comment from a teacher in a study whose focus is something other than this phenomenon. George & Stix (2000) refer to the student motivational difficulties faced by a middle school, social studies teacher who 'teaches to the middle' of the ability range, using only grade-level reading materials in his classroom.

> Each day, [the teacher's] students entered the room, sat in desks arranged in straight rows, copied a paragraph from the textbook that [the teacher] had written on the chalkboard, then listened as he lectured on the paragraph and asked occasional questions for the remainder of the forty-five minute period. (George & Stix, 2000, p.25)

MacKinnon & Brown (1994) studied the problems teachers encountered when they were required to integrate 'special needs' students into their classrooms. A teacher is reported to have commented that she previously 'taught to the middle', but could not do that any more because there were many "kids who did not fit into "the system" (p.137). Finally, a study of teachers' work (Mander, 1997) drew comparisons, between the working environments of teachers in two different schools. One of the participants in Mander's study, a teacher of English who felt unsupported by her school's administrative team, commented that she 'teaches to the middle' in her large mixed ability group classes. Observations indicate that she does not notice a student who is "sitting quietly, but not attempting to do any work" (Mander, 1997, p.8). In fact, she had noticed this student, but both the teacher and the student had given up on each other, as long as each causes the other no trouble. In each of these articles, it is reported that teachers have used the phrase 'teach to the middle' to describe their teaching. The researchers have assumed that their understanding for the phrase is compatible with the teachers' meaning when they have used it. The assumed meaning had been assimilated into their studies without further investigation. In each of the studies, references were made to teaching practices and classroom procedures, which led me to wonder whether I could label 'teaching to the middle' a teaching practice.

What is Teaching Practice?

Teaching practices are often referred to and even described in detail in the literature. Gregoire (1999) closely examined the classroom and preparation practices of a 'good' grade five mathematics teacher. Gregg (1995) examined a first year teacher's prevailing classroom practices. While these and many other descriptions, present a picture, they do not define teaching practice.

As I approached my research, I began to question whether the expression 'teaching to the middle' describes a teaching practice. Finding a definition of 'teaching practice' proved quite challenging. There were many descriptions of teaching practices, some of which have been described as exemplars of effective practices in mathematics teaching (Simmt, 1999) and other descriptions of teacher/student interactions (Clements, 1997; Jarworski, 1992; Lampert, 1990). Most often research examines a part of teaching practice rather than the whole. As I proceed with my research I shall attempt to answer my question by referring to the definition of teaching practice articulated by Simon and Tzur (1999), which I consider encompasses the many facets of teaching practice.

> Te*aching practice* indicates not only everything teachers do that contributes to their teaching (planning, assessing, interacting with students) but also everything teachers think about, know, and believe about what they do. In addition, teachers' intuitions, skills, values and feelings about what they do are part of their practice. Thus, we see a teacher's practice as a conglomerate that can not be understood by looking at parts split off from the whole (i.e. looking only at beliefs or methods of questioning or mathematical knowledge). (p. 24)

The Shaping of Teaching Practice

Whether 'teaching to the middle' is shown to be a teaching practice or not, teachers use the phrase to communicate something about their teaching situation. Everyday mathematics teachers make decisions about their instructional practices based upon a myriad of interconnected factors and influences.

> The practice of teaching mathematics depends upon some key elements, most noticeably:
>
> > The teacher's mental contents or schemas, particularly the systems of beliefs concerning mathematics and its teaching and learning;
> > The social context of the teaching situation, particularly the constraints and opportunities it provides; and
> > The teacher's level of thought processes and reflection (Ernest, 1989).

From these suggestions one can infer that teachers' practices might be influenced by:

- Their beliefs about the nature of mathematics;
- Their knowledge of mathematics and pedagogy;
- Their perceptions of the role of the teacher and the student in mathematics classrooms;
- The social, political and economic context in which teachers work.

The practical activity of teaching, and the way it is understood by teachers, is shaped and guided by these influences, whether teachers recognize this consciously or not (Thompson, 1984). Ross, Cornett & Mc Cutcheon (1992) contend that the basis for all practical activities, such as teaching, is formed by the inter-relationship of

teachers' personal theories and their beliefs, and results in teachers' personal, practical theories that shape their decision making and instructional practices This study, in examining the meaning that teachers have for a phrase they use to describe what they do in classrooms, is informed by research that has investigated and described the factors that influence teachers' actions and decision making.

Teachers' Beliefs about the Nature of Mathematics

Philosophies of mathematics

Discussions about the nature of mathematics have been entered into since the time of Plato. Today, philosophers, mathematicians and mathematics educators continue a debate that rests on four twentieth century foundational movements of mathematics. Mathematics as logic (logicism), as manipulation of objects in a formal system (formalism), as a reflection of man's way of reasoning (intuitivism, also known as constructivism) and mathematics as models of possibilities, open to proof and refutation (hypothetical movement) (Ernest 1991).

There is a range of perspectives within these philosophies of mathematics, which can be categorizes as absolutist or fallibilist (Lerman, 1983). The absolutist view sees mathematics as "objective, absolute, certain and an incorrigible body of knowledge which rests on the firm foundation of deductive logic" (Ernest, 1996), and includes logicism, formalism, inutivism and Platonism. The outcome is an image of mathematics as "rigid, fixed, logical, absolute, inhuman, cold, objective, pure, abstract, remote and ultra-rational" (Ernest, 1996). Ernest (1989) distinguishes instrumentalism - "an accumulation of facts, rules and drills" (p.250) - and Platonism - " a static but unified body of knowledge" (p.250) - as philosophies which fit the absolutist category. In terms of the mathematics seen in schools, this view is represented by the application of rules and procedures that have to be learned, right and objective answers arrived at by the one correct route, and tasks, which enable these outcomes. Skemp (1987) calls this instrumental mathematics, "the kind of learning that leads to fixed plans, by which pupils can find their way from particular staring points to required finishing points" (p.14). Fallibilism views mathematics as the result of social processes, eternally open to revision, both in terms of its proofs and its concepts (Lakatos, 1976), and is encompassed by the hypothetical movement. "Mathematics is experienced as warm, human, personal, intuitive, active, collaborative, creative, investigative, cultural, historical, living, related to human situations, enjoyable, full of joy, wonder and beauty" (www. ex.ac.uk/~PErnest/pome/pompart7.htm). This problem-solving philosophy of mathematics as identified by Ernest (1989) "a continually expanding field of human creation and invention" (p.250), encompasses the mathematics propounded by the NCTM Standards (1989, 1991, 1995 & 2000) and mathematics curricula in Alberta (Alberta Learning 1996 , 1997, & 2000).

Teachers' philosophies of mathematics

Teachers' philosophies of mathematics may not be well formed, especially if they have not made a study of this area. Indeed, some teachers may distinguish between the mathematics of school and the mathematics of mathematicians. Teachers may profess a philosophy, which encompasses more than one view of mathematics

without recognizing the conflicting beliefs. Dionne (1984) reported that, on average, Canadian elementary school teachers held views that encompassed Platonic, instrumentalist and problem-solving/constructivist (Ernest, 1989) beliefs about the nature of mathematics. Furthermore, there appears to be a hierarchy of beliefs which follows from elementary school, where teachers hold multiple views of mathematics to junior high and high schools, where, if the beliefs held are reflected in teachers' practice, then it appears that these beliefs are primarily absolutist (Underhill, 1988).

The connection between teachers' professed beliefs about mathematics and instructional practice has been researched and has delivered contradictory findings. Some have found that there are consistencies between beliefs and practice (Kaplan, 1991; Peterson, Fennema, Carpenter & Loef, 1989), while others have found inconsistencies (Cooney, 1985, Thompson, 1984). Some teachers profess one philosophy of mathematics while enacting another, because of the context and constraints that they work within (Thompson, 1984). Kaplan (1991) explains this dichotomy by distinguishing between deep and surface beliefs, and the corresponding pervasive and superficial practices of teachers. He maintains that practice can be shown to be consistent with beliefs, if these distinctions are made. Teachers, whose practice does not reflect their professed beliefs, hold surface rather than deep beliefs that are easily shaken. In a real sense, teachers' philosophies of the mathematics they teach are demonstrated in their teaching actions, regardless of the idealized, un-actualized philosophies they might claim to hold.

Four dominant and distinctive approaches to teaching mathematics have been distinguished:

1. Learner focused teaching that focuses on the student's personal construction of knowledge;
2. Content-focused with an emphasis on conceptual understanding;
3. Content-focused with an emphasis on performance and mastery, and
4. Classroom-focused where teaching is based on knowledge about effective classrooms. (Kuhs & Ball,1986, p.2, cited in Thompson, 1992)

The first three of these approaches broadly reflect the earlier outlined philosophies of mathematics: fallibilist, Platonic, and instrumentalist. The final approach has the potential to reflect fallibilist or absolutist views of mathematics. "One's conception of what mathematics is affects one's conception of how it should be presented. One's manner of presenting it is an indication of what one believes to be most essential in it" (Hersch, 1986 p. 13). In my study, teachers describe their teaching as they explain their meaning for 'teaching to the middle'. If it is my assumption that teachers are able to talk clearly and honestly about their actions and decisions, and are sincere in their wish to add to the understanding of 'teaching to the middle', then their talk reveals their conceptions about mathematics, as they relate to their personal theories of teaching.

Teachers' Knowledge of Mathematics and Pedagogy

Subject matter knowledge

"Knowledge of mathematics is obviously fundamental to being able to help someone else learn it" (Ball, 1988, p.2). But, what type of mathematical knowledge is essential for teachers today? Teachers need to have more than the procedural

knowledge of mathematics often afforded by college and university education and "studying calculus does not present an opportunity to extend the understanding of arithmetic, algebra or geometry – subjects that will be taught" (Ball, 1990, p. 461).

For many teachers their knowledge base may be limited and inadequate for the demands placed upon them by the Standards and the new curricula. (Brophy, 1991; Brown, Cooney & Jones, 1990; Post, Harel, Behr & Lesh, 1988) First, they may have limited substantive knowledge of mathematics, the knowledge of concepts and procedures as well as the underlying principles and meanings and the connections among mathematical ideas (Ball, 1990), resulting from the form of their pre-service mathematics education (including elementary, secondary and tertiary schooling). A second critical aspect of teacher subject knowledge is knowledge about mathematics, "what counts as an answer… what establishes the validity of an answer…. what is involved in doing mathematics" (Ball, 1990, p.458). In the past, mathematics education focused on knowledge of rules and procedures, rather than understanding and making connections. Consequently many teachers, even those with university degrees in mathematics, may be lacking mathematical knowledge of one form or another.

In many Alberta classrooms teachers, who lack a strong background knowledge of or about mathematics, are required to teach the subject, at all levels of schooling. And teachers who feel confident to teach in instrumental, formalist ways are feeling challenged to teach mathematics in ways which meets the requirements of the Alberta curricula (Shulman, 1987; McCabe, 2000). Others, who have confidence in their subject-matter knowledge of and about mathematics under the previous curricula may revert to traditional formalist teaching practices when faced with new material to teach in new ways (Lehrer & Franke, 1992; Manouchehri & Goodman, 2000). "I expect that you'll find a lot of teachers are 'teaching to the middle' at the moment, as [the teachers] start implementing the new programs" (Kieren, private communication October 1999). Similarly, novice teachers with limited mathematical knowledge have been shown to rely heavily on instrumentalist approaches to teaching mathematics, while those with a deeper understanding of the subject and its connections were able to adopt a problem-solving approach (Cooney 1985; Grossman, Wilson & Shulman, 1989; Steinberg, Haymore, & Marks, 1985).

All mathematics teachers in Alberta are implementing new curricula. The teaching reforms associated with these new programs are difficult to achieve (Ball, 1992; Lampert, 1990); some teachers who believe they are enacting mathematics teaching reforms have been challenged to re-think these beliefs (Gregoire, 1999). It is common for teachers to find their confidence in their knowledge base being challenged: a very uncomfortable position for many teachers, who are accustomed to being mathematical authorities in their classrooms. As I investigate teachers' meaning for 'teaching to the middle' in this Alberta teaching situation, the research of teachers in similar situations informs my interpretations.

Pedagogical content knowledge

Pedagogical content knowledge first received attention when Lee Shulman (1986) characterized it as "the particular form of content knowledge that embodies the aspects of content most germane to its teachability" (p.9). This includes

> for the most regularly taught topics in one's subject area, the most useful forms of representation of these ideas, the most powerful analogies, illustrations, examples, explanations and demonstrations – in a word, the ways of representing and formulating the subject that makes it comprehensible to other. ... also ... an understanding of what makes the learning of specific topics difficult or easy, the conceptions and preconceptions that students of different ages and background bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986, p.9).

Growth in pedagogical knowledge comes with experience, effort and reflection. Novice teachers, or those, whose practice has not grown with experience, have limited pedagogic knowledge and therefore have fewer options open to them for planning and executing their instruction. Expert teachers, however, have a wide range of pedagogic skills, enabling them to engaging in interactive teaching and to encourage student discourse (should they choose to do this), while being aware of how the lesson is progressing and improvising as necessary. The current reforms are challenging teachers' notions of pedagogy and their sense of efficacy (Smith III, 1996); teachers are challenged to re-think their teaching strategies, what counts as an answer, an explanation, a proof, discourse, conversation and communication. For some, years of teaching experience are being called into question. Teachers, who claim to 'teach to the middle' may perceive of themselves as expert or novice teachers, well-versed in subject matter content with a wide variety of pedagogical skills, or not. However, since Alberta teachers are teaching relatively new curricula, which include mathematical content that is unfamiliar to some teachers and require alternative teaching practices, we can assume that teachers' evaluation of their pedagogic skills will be feature in teachers' meaning for 'teaching to the middle'.

Beliefs about the Role of the Teacher and of the Student

The ways in which teachers describe their actions within their classrooms speak clearly about the views they hold regarding their role in the classroom and that of their students. Their professed beliefs about the nature of mathematics may be aligned to their classroom practices, or may be at odds with these professed beliefs and may more accurately reflect their 'beliefs in action'. One snapshot of teaching might show a teacher telling students mathematics, explaining and demonstrating rules and procedures to a whole class or to groups of students. These teachers are referenced as authorities in the classrooms and there is an expectation that students will follow the methods and procedures the teacher demonstrates. Usually, the textbook plays a prominent role in the lesson and students' answers are invariably checked with the key in the textbook. Students are required to be compliant, receive and memorize knowledge, respond to teacher questions in appropriate ways and then answer questions in the textbook in the manner demonstrated by the teacher. This transmissive pedagogy, frequently associated with the absolutist view of mathematics although there is no specific reason this association (Ernest, 1996), is known as the school mathematics tradition (Gregg, 1995), and is strongly resistant to change (Cuban, 1984).

An alternative view of the role for teachers and students is characterized by teachers who act as facilitators to student learning. These teachers provide tasks for

students to engage in, while offering guidance and support as students work together to find and discuss their own solutions to problems. Textbooks seldom feature prominently in these classrooms, and the students, not the text or the teacher, are regarded as the authority for learning (Ernest, 1989; Kuhs & Ball, 1986). This role for teachers and students is the one outlined in the NCTM Standards (2000), and represents the fallibilist view of socially constructed mathematics.

Teachers may have difficulty assigning themselves to one of these two groups because their beliefs and teaching theories are not clearly differentiated. It is probably easier to consider the two descriptions of traditional and reformed teaching, with their associated roles for teachers and students, as end points along a continuum. Many teachers will be located some where between the end points of this continuum and might be categorized as "traditional", "primarily traditional", "an even mix of traditional and non-traditional", "primarily non-traditional" or "non-traditional", depending upon where their emphases lie (Raymond, 1997).

Words associated with the continuum offered by Raymond (1997) have fallen into general usage and have become almost buzz words or slogans: it may be fashionable or acceptable within the educational community to claim to be a facilitator of student learning. Hence, teachers may describe their role as 'facilitator', while continuing to tightly control the discourse and student learning in ways associated with traditional, transmissive teaching, or may claim their actions are traditional because these are their longstanding practices, even though their actions are more closely related to the teaching reforms. Indeed, the very words used to describe the activity of teachers in classrooms, teach and facilitate, are in themselves troubling. The etymology of the first, together with the prefixes of its synonyms (–in, -en and –dis) supports the banker (Friere,1989) and conduit (Reddy, 1979) metaphors for teaching and the associated roles for teachers and students. The second verb, to facilitate, has become synonymous with the phrase 'to guide from the side'. However, its root, in the Latin falicitare, promises "to render [something] easy" (www.dictionary. oed.com), a notion that is quite at odds with the lived experiences of teachers and students working in constructivist/reformed learning environments. Consequently, it will be important to listen carefully to teacher words and notice the actions and activities they ascribe to them selves and their students, when they reveal their understanding of the phrase 'teaching to the middle'.

Response to Context

The context, in which teachers work, influences teaching practice. Teachers work in complex political, economic and social institutional environments, which demand responses from them; responses that may lead teachers to make changes to their teaching practices (Mander, 1997). Pressure to meet the challenges of high stakes testing for students, to work in economically challenged schools, to meet parental and student expectations of a teacher's role impact teachers' practices (Cooney, 1985; Borko & Elliot, 1999; Foley, 1993). As well, teachers in the same school have often been observed to adopt similar classroom practices because they have faced pressure from their school mathematics community to conform to its approaches (Ernest, 1988). The classroom practices reported by teachers are influenced by their beliefs and knowledge as well as by the constraints and opportunities that occur within the school context (Anderson, 1998).

Labels and Slogans

'Teach to the middle' is certainly a frequently heard expression, but is it a label or a slogan? In relation to educational research, labels and slogans are both recognized terms and have characteristics that identify and define them, which will help to answer this question.

Labels

John Mason, (2001) writes about labels and the role they play in education. Labels unite groups of experiences, which have enough commonality to coalesce under one banner, and have meaning for the people who share those experiences. "Labels summarize experience and act as a focal point for connections and associations" (p.9). For example, the label 'subtraction by decomposition' immediately resonates with those who have learned to subtract in this manner, eliciting brief but vivid recall of fragmentary experiences. It is possible that those hearing this label will remember their teachers, their classroom, pages of examples from the textbook, even a feeling of panic or joy. For others who are either unfamiliar with this label, or associate subtraction with another label (for example, 'equal additions'), there will either be no resonance, or they will associate this label with other experiences.

Labels are useful for naming phenomena, although the experiences associated with the label will necessarily be general rather than particular, unless the label users have agreed taken-as-shared meaning. When 'whole language' was first introduced, many English teachers recognized the label and had a superficial, general understanding of the label. Later, as experience grew the particulars became set in place, 'whole language' became a label full of particulars for its audience, yet still generalized for others.

The label, 'teach to the middle', is recognized by many people, whether they have a specific or a general meaning for it. It vividly resonates with the lived experiences of those who claim to teach this way, although we do not know whether these experiences are shared or not. For those who only hear the phrase, and do not claim to teach this way, the label remains general, personal interpretation of the phrase, reflecting their own past experiences. Labels can be very useful because it is possible to respond to them 'in the moment', catching oneself just before one falls into a habitual action (Mason, 2001). In this way they offer the opportunity to change habits. Thus, if teachers are aware of the label 'teach to the middle' and its resonances, it is possible for them to alter their practices, or if they choose not to do so, to be fully aware, in the moment, of their actions.

Slogans

Educational practice is peppered with slogans from those that refer to general practices ('open education', 'progressive teaching', 'traditional schooling') to those which are associated with specific practices ('whole language', 'inquiry-based learning') and mathematics specifically ('the Standards', 'fuzzy math', 'mathematics for all'). Some of these slogans or buzz-words are well discussed and their meaning is understood. Others are relatively new and are used with a taken-as-shared meaning, assuming that in time the specifics will be defined and teachers will be helped by this

definition. 'Teaching to the middle' is a phrase, which may be a slogan and as such it has a taken-as-shared meaning. Those who utter it and those who hear it assume they share the same understanding of the expression. However, we do not know whether or not this is true.

The Oxford English dictionary gives a meaning for the word slogan: It is "a distinctive war-cry, or a battle cry … usually consisting of a personal name or the name of a gathering place" (www.dictionary.oed.com). The Merriam-Webster dictionary reveals "1.a) A war cry or rallying cry, a catch phrase…b) a word or phrase used to express a characteristic position or stand, or goal to be achieved… 2. A brief attention getting phrase used in advertising" (www.m-w.com). In structure slogans are usually short phrases, sentence fragments, descriptive, evaluative, prescriptive, imperative or comparative statements, and they use ambiguous words or terms that are associated with a movement (Blinn, 1981). The purpose of a slogan is to catch the attention of those who hear or read it, to attract people to a particular position of stance and to foster community spirit (Scheffler, 1960, cited in Blinn, 1981). 'Teach to the middle' is certainly a short phrase that catches the attention of those who read or hear it. The phrase brings together those who claim to teach this way, in a community of isolated members. (This isolation is typical of the teaching community, where teachers tend to work isolated from each other rather than in collaboration (Ball, 1996).) The words 'teach' and 'middle' are both recognized educational terms and ambiguous, leaving interpretation open to the listener/reader.

Slogans are often rallying calls towards a general direction to educational reform (for example, 'we teach children, not subjects', or 'inclusive mathematics'), although sometimes their literal meaning makes no sense. After all there would be no support for a movement that did not try to have children learn anything. Slogans acquire their meaning through individual or group interpretation, and consequently, they may have multiple meanings. For example, the slogans of Dewey's progressive education movement developed different meanings from those in the context of Dewey's writing. In the case of Dewey, the slogans came from within a carefully thought out work. In the case of 'teach to the middle', I wonder if the slogan has arisen to encompass the experiences of a group of teachers. They are called together under the slogan of 'teaching to the middle', a slogan whose particulars and generalities have yet to be revealed.

Speaking Metaphorically

Metaphors are ever-present in our language and our thinking. They permeate our language to the extent that we seldom notice them or consciously register their impact and commentary. Although they often do not make literal sense enable us to create pictures and communicate pictures that go beyond the literal usage of words, and we are able to understand one thing in terms of another. For example in the metaphor, 'a sea of faces looked up at me', we understand the diversity of bodies and personalities blended into one entity, in terms of a body of water (Lakoff & Johnson, 1980; Ortony, 1979). Beyond this linguistic use, metaphors may also convey concepts. 'The classroom is a battle field' is not a very encouraging metaphor, but a classroom, where teachers and students feel they are at odds, with each other or the subject matter, may use verbs, adjectives and phrases that convey a battlefield notion:

'fight through the problem'; 'don't give in'; 'push forward'; 'it's me against them'; 'subdue the students', or 'they target my weaknesses'.

Another common metaphor is one in which schools are referred to as factories or work places in which students perform 'seatwork', are graded according to their work habits, and are exhorted by their teacher/supervisors to 'get on with your work' or 'to begin working immediately upon entering the classroom'. Using a different metaphor ('start with what you know'; 'authentic activities'; 'think first, speak second'; 'negotiation', 'question whether your answers are reasonable') conveys a situation wherein schools may be construed as learning environments. Reddy (1979) describes two metaphors (conduit and toolmaker) that provide commentary upon the end points of Raymond's (1997) continuum. The conduit metaphor, in which ideas are transferred from one person into another, whole and complete, requiring no effort from the receiver, other than the willingness to take delivery of the transfer, effectively mirrors the traditional, transmissive model of teaching, and highlights the inherent difficulties that accrue to both teacher and students. The toolmaker metaphor, in which teacher and students exchange, back and forth, a blueprint that is constantly modified and adapted to fit each one's circumstances, reflects the nature of social constructivism, the foundation of new mathematics curricula, including that found in the Alberta education system.

Reddy (1979) and Lakoff & Johnson (1980) argue that metaphor is omnipresent in the English language, and it is almost impossible to speak without metaphor. Consequently, when we speak we reveal the concepts and perceptions that guide our thoughts and actions. When teacher explain their meaning for the phrase 'teach to the middle', the language and the words that they use will reveal the personal theories and beliefs that underpin their teaching decisions and add to my understanding of this phrase.

Conclusion

In this chapter I have reviewed what is known so far about 'teaching to the middle', and the literature regarding some of the factors that have been shown to contribute to and/or act as constraints upon teachers' actions, decision making and creation of personal practical theories. Furthermore, I have provided an insight into slogans theory and labels, and suggested that an examination of teachers' metaphoric speech may be a useful way to explore the teachers' stories of 'teaching to the middle'. In the next chapter I will talk about the research method and the procedures I used in this study.

CHAPTER III

Research Method

Introduction

Historically, research about mathematics teaching has focused on quasi-experimental studies, which sought to discover relationships among various teaching and learning factors. These studies can be characterized as working with few tightly controlled variables and many cases as researchers test theories that explain phenomena (Creswell, 1998). In the last two decades, qualitative studies have become more common in many areas of research including educational research. Based upon the belief that human behaviour is bound to the context in which it occurs, qualitative research allows the study of phenomena, encompassing many rather than few variables, and culminates with a complex, holistic picture of the phenomenon in its natural setting (Creswell, 1998).

As suggested in the previous chapter, teaching is a complex activity; a result of many influences, which interconnect and intersect and result in a highly personalized pedagogy, for which teachers may or may not have a clearly delineated basis. Because I wanted to relate, understand and interpret teachers' experiences and meaning that teachers who 'teach to the middle' have for the phrase, I knew from the start that I would not seek to quantify my findings. Rather, a qualitative research study would be suitable for my middle' phenomenon.

Choosing a Tradition

My conclusion, that qualitative research would be appropriate for my study, prompted me to investigate a number of traditions within the field of qualitative research. "Only a few years ago, some called all qualitative research "Ethnographic" " (Creswell, 1998, p.3). Since then, a large number of qualitative research orientations have evolved: Tesch (1990, cited in Merriam, 1998) indicates that at least twenty-eight approaches exist. Among this diversity of choice I found that

> education has recognized the advantage of using a case study approach for better understanding of the process or dynamics of certain aspects of practice. All levels of education – preschool though adult – contain many questions that might best be dealt with by the case study approach. (Merriam, 1988, p.204)

and that,

> the case study offers a means of investigating complex social units consisting of multiple variables of potential importance in understanding the phenomenon. Anchored in real-life situations, the case study results in a rich and holistic account of a phenomenon. (Merriam, 1988, p.32)

While researchers have not agreed upon a common definition of case study research, most have agreed that case study research takes place in a natural setting and strives to provides a holistic interpretation of the phenomenon being studied. Van Manen (1998) says: "qualitative research (*qualis* means "whatness") asks the *ti estin* question: What is it? What is the phenomenon in its whatness?" (p. 33). A qualitative case study allows me to ask such a fundamental question and to present my

interpretations as a possible answer, in a manner that will allow readers to develop an empathetic understanding of the phenomenon.

> Case study is the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances (p.xi) ... We are interested in [persons and programs] for both their uniqueness and their commonality. We seek to understand them, we would like to hear their stories. We may have reservations about some things the people ... tell us, just as they will questions some of the things we will tell them, but we enter the scene with a sincere interest in learning how they function in their ordinary pursuits and milieus with a willingness to put aside many presumptions while we learn. (p.1)

I chose a descriptive, qualitative case study (Stake,1995) for my work, because I wanted to investigate the meanings that teachers, who say that they 'teach to the middle' have for the phrase, by listening to their stories and probing their explanations. The six teachers' responses to this phrase, informed my understandings and interpretations, as I strove to fulfill my goal of creating a resonating revelation of this teaching phenomenon.

Selection of Participants

"Case study research is not sampling research" (Stake, 1995, p.4).

As I thought about ways to collect data for my study, my first concern was to identify, with as little impact as possible, teachers who claimed to 'teach to the middle', As noted earlier, the only documented references to 'teaching to the middle' (George & Stix, 2000; MacKinnon & Brown, 1994; Mander, 1997) attach a negative connotation to the practice. This being the case, I wanted to ensure teacher privacy from the earliest possible moment, while collecting information from as broad a group of mathematics teachers as possible. At the same time, I wanted to select my participants from as large a pool as possible, so that I could be selective and include variation and diversity. I decided to distribute a survey to all participants at the Annual Conference of the Mathematics Council of the Alberta Teachers Association's conference (MCATA). I reasoned that teachers who attended this conference would have an interest in the teaching of mathematics, and I assumed that those who completed and returned my survey would have some interest in and knowledge of 'teaching to the middle'. Finally, I rationalized that those who chose to participate in the interview stage of my research would feel that they had value to add to the study.

The Teacher Participants

I had hoped that teachers working in all levels of schooling would agree to participate in the interview section of my study because "maximum variation [should be employed] to represent diverse cases to fully display multiple perspectives about the cases" (Cresswell, 1998, p.120). Unfortunately, none of the elementary teachers who claimed to 'teach to the middle' was willing to be involved. Those who did agree to participate and provided most of the data for my study were secondary school teachers: Martha, Diane, David, Steve, Sara and Judith. All except David, who is a junior high school teacher, are high school mathematics teachers. Only Martha and Judith teach in rural schools. The experience of these teachers is diverse: from four

years to twenty-six years, in elementary, junior high and senior high schools, and with students in gifted and special education programs and students 'at risk', in mathematics and other subject areas. Only Judith has worked as a teacher outside Alberta.

Table 3: *A Description of the Teachers in the Study*

Teacher	Education	Math Specialist	Years Teaching	Teaching Experiences
Martha	B. Sc M. Ed	Math major	26	Junior high 5 years Senior high 21 years Teaches all high school math programs
Diane	B. Sc. Graduate Diploma	Math major	26	Senior high 26 years Has taught the AP program and academic challenge courses Teaches Pure & Applied Math and Math 31
Steve	B. Ed.	No	19	Junior high 13 years Senior high 6 years Special education trained Worked with 'juvenile delinquents' Has taught classes of high achievers[1] Teaches Pure & Applied Math
Sara	B. Comm. B. Ed.	Math major	4	Junior high 3 years Senior high 1year Has taught classes of high achievers[3] Teaches Pure & Applied Math and Math 14/24
David	B. Ed.	Math minor	12	Elementary 3 years Junior high 9 years Special education background Teaches grade 7, 8 & 9 mathematics
Judith	B. Sc. B. Ed. M.Ed.	Math major	7	Senior high 7 years Has taught outside Alberta Has taught 'children at risk' in a northern community Teaches Pure & Applied Math and Special Needs class

[1] In these teachers' schools, students who are high achievers are taught together in a class, named Pure Math 10/20/30E.

Data Gathering

> "But why do we need to collect the "data" of *other* peoples' experience? We gather *other people's experiences* because they allow us to become more experienced ourselves" (van Manen, 1998, p. 62).

"There is no particular moment when data gathering begins" (Stake, 1995). In this regard, I began to collect data informally as soon as my awareness was raised to the phrase, listening for it to be spoken again, and collecting colleagues' responses to the phrase. However, in order to make the best use of the time available for researching the topic, it was necessary to organize the way in which data was to be collected. Stake (1995) and Cresswell (1998) suggest using multiple sources for data collection. My primary source of data was the six teacher participants, but my data was built up in three stages. First from a survey, which gave me a feeling for the ways in which the phrase was understood in the population of Alberta's mathematics teachers. Then the teachers participants completed a questionnaire, which I designed to focus the teachers' attention on their beliefs and attitudes towards mathematics and its teaching. Finally, I gathered data during an interview, as I sought out each teacher's particular meanings for the phrase, and characteristics. Since the purpose of my study was to gain an understanding of teachers' meaning for the phrase 'teach to the middle', I decided not to use direct observation of each teacher, since it would take my study in a different direction.

The Survey

In order to gain a broad understanding of the meaning mathematics teachers have for the phrase 'teach to the middle' I collected data in the form of a survey. The use of a survey instrument (see Appendix C) allowed me to identify teachers who claimed to teach to the middle, to collect data about the respondents' educational background and teaching experience, as well as the names of those who were willing to participate further in the study. Teachers were only asked to provide their name and a contact telephone number or e-mail address, if they were willing to participate in an interview. In this way, I was able to collect data without sacrificing the anonymity and confidentiality of those who would not be interviewed. In addition, from this survey, I was able to collect a variety of meanings that teachers had for the phrase 'teaching to the middle', whether they claimed to teach this way or not. I distributed four hundred surveys; sixty-seven teachers, from all levels of schooling, returned them to me.

Survey findings

My own experiences led me to believe that the phrase 'teach to the middle' is familiar to educators; I have found that the phrase resonates with those who hear it. Only two of the sixty-seven respondent teachers indicated that they were unaware of the phrase, having never heard it. As I examined the survey responses, I realised that there were teachers of mathematics, teaching at all grade levels in Alberta, who claimed to 'teach to the middle'. Twenty-three teachers indicated that they 'teach to the middle'; as well, seven claimed to 'teach to the middle' sometimes. Approximately the same number of junior and senior high school teachers claimed to teach to the middle, although the number of elementary teachers making this claim was far fewer.

The teaching experiences of these educators ranged from two months to over

thirty years, in a variety of contexts: elementary, junior high, senior high, K-9 and K-12, rural and urban schools. Some teachers had received an education in preparation for teaching at the secondary or elementary level but were not teaching at these levels, others were. The teachers' qualifications were wide ranging, from those who have Bachelor's degrees in Education, Mathematics, Science, Accounting, and Commerce to those who have undertaken postgraduate work in education, science, or problem-solving: several teachers have completed more than one degree. There were teachers who considered themselves specialist mathematics teachers, and those who did not. In Alberta, teachers who claim to 'teach to the middle' can be found in a variety of teaching environments, with diverse teaching experiences and educational backgrounds. The teachers who informed this study reflected this miscellany, except that no elementary teacher volunteered their stories.

As will become clear in subsequent chapters, although the teachers' meanings for 'teaching to the middle' were necessarily personal, the five high school teachers share many commonalities in their implicit beliefs about the nature of mathematics and it's teaching and learning, which in turn are reflected in their communicated experiences of 'teaching to the middle'. The sixth teacher (David)'s description of this phrase diverged in certain aspects from those of his peers, most noticeably in his conceptions about teaching, his perceptions regarding the individuality of his students and the ways in which he attempts to connect these ideas.

The third question on the survey invited teachers to explain what the phrase 'teach to the middle' meant to them. The responses indicated that these teachers felt that 'teaching to the middle' was about

- teaching the 'average' student;
- directing instruction towards the majority or most of the students, but offering challenge or remediation, thereby appealing to the greatest number of students;
- choosing content that most students can understand;
- ignoring the weakest and the strongest students;
- using the understanding/skill level of the middle students as a starting point;
- teaching to the capabilities, abilities and understanding of those students who attain marks between 50 and 70%;
- the normal distribution, where most students fall into the middle section of the curve rather than either of the two ends;
- teaching students who either do not like math or 'do not get it';
- teaching at a pace that most students can keep up with;
- finding a way to cope with the teacher's overwhelming work load by focusing on the average student;
- translating mathematics into language the average student can understand.

The Questionnaire

In anticipation of the scheduled interviews, the participating teachers were given a questionnaire to complete. The intention of the questionnaire was to focus the teachers' thoughts about the teaching decisions they make in their classrooms and to oriented their thinking towards some of the factors which have been shown to shape

instructional decisions. I constructed the questionnaire (see appendix D) using a five point Likert scale ('strongly disagree', 'disagree', 'neutral', 'agree' and 'strongly agree'), so that participants could respond to statements regarding the nature of mathematics, the roles of teachers and students, and the influences that impact teaching decisions. At the conclusion of the questionnaire, participants were asked to indicate the degree of emphasis (none, little or much) that they placed upon a variety of activities. The individual teacher's responses on the survey and the questionnaire, as well as the general responses collected on the survey at the Alberta Teachers' Association Mathematics Conference, served to form the basis for the conversation at the interview.

Critique of the questionnaire.

I found the questionnaire responses to be contradictory and difficult to categorize. One teacher agreed that mathematics is *fixed and bounded* and that it is *fallible, open to revision and conjecture.* All the teachers confirmed their belief that *mathematics is like a game with rules to be learned.* Teachers held apparently contradictory beliefs such as *students must be shown how to do mathematics* and *students can explore their own mathematics knowledge,* or *the student's role is to explore, question and investigate* together with *the student's role is to learn what the teacher presents.* The teachers had difficulty generalizing their responses: *it depends on the context, it depends on the students,* and *are we talking about school mathematics or mathematics, I'll answer for school mathematics here,* were annotations that appeared beside questionnaire responses. (Similar notions permeated the later conversations I had with the teachers.) A dichotomy was apparent in other responses where teachers differentiated their own approach to mathematics (problem-solving) from the approach they expected their students to use (learn what the teacher tells you).

From the teachers' responses I have drawn several conclusions regarding the efficacy of the questionnaire. The instrument directed the respondents to think about mathematics and their role in its teaching in ways that they may not have considered previously. Asked to pin-point their beliefs about mathematics and its teaching, it became clear that for these teachers, their beliefs were far from clear cut or coherent. The questionnaire was not sufficiently detailed or probing to elicit particularly useful responses about teachers' professed belief systems or philosophical underpinnings. As well, it was an isolated instrument: four of the teachers completed the questionnaire immediately before the interview having forgotten to do so earlier; none of the teachers asked about the relevance of the questionnaire to the research. The questionnaire demanded instant, Likert scale responses, when clearly teachers had much more to say in context. The information gathered from the questionnaire contributed to my understanding of 'teaching to the middle', but the responses were abstract and disconnected from teaching stories, representing snapshots of belief in the moment (Anderson, 1998), when we know that beliefs are fluid and respond to experience and influences (Thompson, 1992). When teachers spoke about their teaching and illustrated their comments with classroom stories of their experiences, a much clearer picture of their deeply held beliefs and philosophies 'in action' became apparent.

The Interview

> Qualitative case studies seldom proceed as a survey with the same questions asked of each respondent; rather, each interviewee is expected to have had unique experiences, special stories to tell.... The purpose, for the most part, is not to get simple yes or no answers, but descriptions of an episode, a linkage, an explanation. (Stake, 1995, p. 65)

An interview of about one hour's duration was scheduled with each teacher. The intention of this interview was to listen to and record teacher's stories of 'teaching to the middle' and to try to clarify the following:

- The teacher's meaning for and understanding of the expression 'teach to the middle';
- The teacher's description of his/her teaching and the philosophies/beliefs/constraints that support or influence this approach;
- The characteristics of teachers who 'teach to the middle';
- In what sense the word 'middle' is used;
- How the middle is determined, and
- Whether the teacher finds that the middle varies when more than one group of students is taught, and if so, in which ways.

The interviews were conducted at the University of Alberta, which proved to be a convenient location for all the participants. I found that the teachers came prepared to talk immediately about 'teaching to the middle', and each had their own focus of attention around the subject. Often a conversation began at the threshold of the room, as we exchanged greetings, and continued as they departed. Consequently, although I had prepared a set of questions for the interview, the direction of the interview followed the direction of the conversation and the focus of attention of each teacher. Ultimately, each interview was quite different, but eventually covered each area of interest I had identified.

Data Analysis and Interpretation

Organizing the Data

The data from the surveys were transcribed onto a chart where I recorded each teacher's response to the question "What do you think the expression [teach to the middle] means? Give an example", and noted comments that I thought might provide direction during the interviews. I also prepared a chart, which summarized the educational background and experience of the teachers who had returned the survey to me. I prepared a colour-coded file for each of the teacher participants, which included the initial survey response, the questionnaire, the tape recording of their interview, and a transcript of the interview. After reviewing my proposal to remind my self of my particular areas of interest, I went through the transcripts repeatedly, noting interesting things that each teacher had said. I began to notice that, although each interview followed the concerns and interests of the teacher, some themes began to emerge. I drew a web for each teacher, which reflected what I thought they had said about 'teaching to the middle', and included my impressions of the teacher and key words. This helped to organize my thoughts and perceptions, as well as to identify patterns, construct themes and articulate my perspectives of the teachers. I re-visited

my transcripts often, seeking connections between my webs and the teachers' comments, and themes to organize the data around.

Interpretation

"There is no particular moment when data analysis begins. Analysis is a matter of giving meaning to the first impression as well as the final compilations" (Stake, 1995, p.73). I might also say that there is no particular moment when interpretation begins. In a qualitative case study it is necessary to regard analysis of the data and its interpretation as an integral part of the process of collecting data. Thus, as I collected data from the surveys, the questionnaires and the interviews, I began to form impressions and themes began to emerge without a formal analysis of the data: suggestions of interpretation began to emerge; suggestions of interpretations began to form. Also, the data collected from a survey, questionnaire or interview became material to investigate with subsequent participants. As I collected data, I stored the impressions and interpretations, resisting the urge to prematurely develop themes, and I endeavoured to maintain an open, unbiased mind ready to be surprised by my discoveries. However, in making this statement, I am aware that all my impressions and interpretations will be far from unbiased: they are my construct to explain what I am hearing in light of my own prior and contemporary experiences.

Interpretation is an essential component of case study research. "According to one highly respected writer on qualitative studies, Fred Erickson, the most distinctive characteristic of qualitative inquiry is its emphasis on interpretation" (Stake, 1995, p. 8). The teacher participants in my study related their interpretation of their experiences of 'teaching to the middle', as they understood them at the time of our conversations. Listening to the teachers, initially and later on audiotape, I added my own interpretation of their experiences in light of my own experiences as a student, teacher, researcher and parent. Although I may have had very similar experiences to the teachers, mine can never be identical. Each of the teacher's experiences have been subjected to influences particular and peculiar, rendering them unique. As I relate these interpretations of experience in the following chapters, I am interpreting them within my own set of unique influences. The test of the accuracy and relevance of my writing will be the degree of resonance experienced by the readers of my descriptions.

Writing the Report

While there is no standard format for case study writing, the story may be told through techniques such as a chronology of major events followed by close-up or detailed perspectives of specific events (Creswell, 1998). I chose to follow much of Stake's (1995) suggestion with an entry vignette, a discussion of the issue, followed by the purpose and method of the study, and data chapters that tell each teacher's story of 'teaching to the middle', as I understood it.

I chose to use vivid description in telling the teachers stories, using their words, unaltered, except that I removed some peculiarities of speech (such as ums and uhs), as I tried to capture a sense of the uniqueness of each teacher's story. Van Manen (1998) says "a good … description is collected by lived experience and recollects lived experience – is validated by lived experience and it validates lived

experience" (p.27). In applying this standard to my descriptions, I hope that readers will experience resonance with the lived experience described by the participants.

My writing of the teachers' stories was submitted to them for their comments, an action that afforded the teachers an opportunity to correct any mis-understanding that might have occurred and to change their comments in light of later reflection. This process is one that Stake (1995) calls triangulation of warranting. Later, in chapters ten and eleven, I reflect upon the teacher's stories, draw conclusions, and discuss the implications arising from my understanding of 'teaching to the middle'. This process was one of piecing together "snippet[s] of information" (Stake, 1995, p.75), pulled apart from here and there, as I attempted to form an aggregate impression of 'teaching to the middle', and to identify emerging themes. The impressions formed are my own, a construct built of my own peculiarities, and not stated with any certainty or universality. Indeed, I am resisting the temptation of certainty, resting in the knowledge that readers of my words will form their own impressions, which may or may not coincide with mine.

The purpose of my study is to uncover the meaning that these six teachers have for their lived experience of 'teaching to the middle', and to make the phenomenon more understandable by discussing the themes, which characterize the phenomenon. "We do not study a case primarily to understand other cases. Our first obligation is to understand this one" (Stake, 1995, p.4). I do not make broad generalizations about 'teaching to the middle', but I present clear, complete and descriptive accounts of the experiences of six teachers who claim to 'teach to the middle'. In doing this, I hope the reader will find the descriptions familiar, be able to make connections with his or her own prior knowledge and/or experience and form naturalistic generalizations about the phenomenon.

In this chapter I have outlined the methods I used as I sought to discover the meaning that mathematics teachers, who claim to 'teach to the middle' have for the phrase. In the following six chapters, I present each teacher's story of his or her understanding of the 'teaching to the middle' phenomenon; a story of each individual's usage and interpretation of the phrase.

CHAPTER IV

Martha's Story

Background

Martha is a specialist, secondary school mathematics teacher. She majored in mathematics and has completed a Master's degree in Mathematics Education. She has been teaching for twenty-five years, five years of which was at the junior high level and twenty in high school. Martha works, and has worked for many years, in a rural Alberta high school, where she is respected for the quality of her teaching and her involvement with her students. Martha has taught all the mathematics programs currently prescribed by Alberta Learning. Her teaching assignment this year includes the Pure 10, 20, 30, Applied Mathematics 10, 30 and Mathematics 14 courses. Martha is an established, experienced leader in her mathematics department; a person to whom others turn for advice and guidance. At this stage of her career, Martha is looking forward to retirement from school teaching, when she hopes to pursue other educational and career goals.

Martha's Teaching Style

Martha is a traditional teacher who says she engages in direct teaching, primarily, the whole class. In Martha's opinion, her style of teaching is similar to that of other mathematics teachers in her school, with whom she meets regularly to discuss teaching strategies. Martha says it is her role as a teacher is to explain and illustrate concepts so that most students will understand them. This means translating mathematics into a language that she feels her students can understand, and breaking the concepts down into smaller pieces that can be learned and then re-assembled. Although her lessons may vary somewhat from day to day, typically her lessons will follow a familiar format:

> *I think in planning the lesson, part of what we do is to try to interpret whatever we're presenting for that particular day in a language that's understandable by students who may not have everything in their heads to do the concept. It would mean working in some review, some lead up material, that prepares them to accept the lesson and brings back what they hopefully have in their heads. Going through the concept in several steps, breaking it down into an understandable form. Giving practice that is graduated. Giving examples that they can look at, that are graduated so they will hopefully move from where they are to where you want them to be ... it's definitely direct instruction.*

Students are sometimes allowed to work together, in pairs or groups, but the emphasis is on individual seatwork. Martha has found that the Applied Mathematics programs call for an inquiry/project approach; in these classes students may work in pairs or groups to complete the investigations, although the primary emphasis is still on whole class teaching.

Martha has found that her expository style of teaching interferes with good problem solving, which she feels is an important aspect of mathematics. She has tried to include problem-solving in her teaching approach, but she finds that most of her

students expect to be told what to do and consequently wait to hear Martha's explanations, rather than developing their own.

> *... when you would like to present a problem that the students should be ready to engage in and you would like to present it without a lot of your own stuff first ... most of the students in the class will not be prepared to do that. For a couple of reasons: one of them is that they don't remember what they've been taught. So the curriculum might tell you that they've learned how to solve two-step linear equations in grade 9 or grade 10, but you present them to your grade 11s and you'll find that there are still people who don't remember the process. So, there you are with your wonderful new concept. ...You maybe have five people who understand what you are talking about and can engage in the problem at the level you would like them to engage in the problem, and an awful lot of people are sitting around waiting for you to tell them how to do it, because that is how they have always operated. Students always assume that they are going to have a lot of preparation and so on. I think this is what we do - teach to the middle, because we're teaching someone who is not quite prepared, not quite ready, not willing to take risks.*

Martha has noticed that in each of her classes, she has a few students who are ready to move along with the mathematics, but by far the largest group is composed of those who "*are not quite ready, not quite prepared, not willing to take risks*". These are the students she calls the 'middle' group and it is for these students that she shapes her instruction. However, she finds that the ability, attitude and performance of students in the middle groups varies from class to class, so that the 'middle' in two parallel classes (Math 20 for example) may be different.

> *... because classes differ a lot in character. And sometimes, the middle, is in a different place. It seems to you the middle is in a different place.*

The Middle

Middle Students

Martha plans her instruction for the middle group of students, trying to reach as many students as possible, but recognizing that some will not be reached. In any of her classes there will be about five students who are the top- or upper-end and about the same number at the lower-end, although these number do vary from class to class. Whether Martha is teaching a Math 31 class (a high level mathematics program for those intending to pursue mathematics or engineering at the university level) or a Mathematics 14 class (a course covering the mathematics of everyday life), she is able to identify a middle group of students. Generally, Martha estimates that the achievement of the middle group of students falls within approximately one standard deviation of the class mean, although she acknowledges the difficulty in pinpointing the middle group and the level at which they are working.

> *And in some classes that average student seems to be a little more capable. That may be total perception on the teacher's part because of one or two who are able to carry the discussion along a little better. So you would aim your instruction at where you perceive the average student would understand it. ...*

[The middle is] *where we think it is, based on the responses of students and the frowns on their faces and the questions they ask and their performance on tests and that sort of thing.*

Also, whether individual students are perceived as being in the 'middle' group or not depends upon the composition of the class in which students find themselves.

I have a number of students that would be considered middle in my Pure 20 class, but they would be considered top-end in an Applied Math 20 class, and they would be considered exceptional in a Math 24 class. So, a lot of it is the group of your peers. And I'm sure if you took my Pure Math 20's and put them in a grade 11 Math class, in a school where the students were in IB (International Baccalaureate*) or AP (*Advanced Placement*) programs, and they were merged, they wouldn't be in the middle any more. They'd be fighting for their lives. So, I think it's a relative thing. Pretty relative.*

Martha plans her teaching around her perception of the abilities of the middle students and she believes her teaching will meet the needs of these students. I asked Martha to reflect upon the characteristics of the students she perceives as being in the 'middle'.

The students we perceive as being in the middle [are] the ones that have sort of accomplished our main goals. [They] *are probably the ones that are still not able to finish everything, not able to really follow problem solving. They can copy it down, they can memorize it, but they don't really have the ability to engage in the problem on their own. They are using some ones else's knowledge and kind of absorbing that. But, I think our middle group don't always make it through all the examples or understand all the stuff, but we feel comfortable that we've been able to teach them the basic outcomes, that they've accomplished the outcomes that are set out in the documents we work with. But they may not have been able to carry them out at a very strong level. So, if you change the complexity of the problem, they would not be able to do that. ...A lot of the, quote, middle students are good workers; do have strong understanding. They are just not the ones who perhaps see the big picture. Perhaps they have a sufficient handle on everything to solve a difficult problem – they are willing to put some effort into what they're doing, but the effort never really guarantees them good results.*

Students are members of this middle group because they work hard and do everything that is asked of them, but still do not get good results, or because they choose to be in the middle group. She reflects that often it is a personal approach rather than ability that leads to the student's position in the class. Martha is very concerned about a group of potentially top-end students whom she feels may have been trained to work to a 'middle' level, and are subsequently in the middle group of students.

[Some of] *the top end group have been trained, I think have been trained to work at the middle level. They make the assumption that the standard is this, they will do what they've been asked to do and I have met very few, who really want to be drawn out of that, even though they are quite capable. But they feel, "Oh, that's a lot more work and I have a life and a job and a couple of other core courses and I really don't, don't want to be drawn outside the middle.*

In the Applied Math program, in particular, Martha sees that there is plenty of room for the top-end students to take the initiative and work to their potential. The student projects allow for students to be creative in their reporting and to take their investigations as far as they want to. In these classes, Martha had hoped to see students taking the responsibility for their own work and producing very good results.

> *Theoretically, you know, top end-students should be able to break away and do wonderful things. And to an extent that may be true. I think we have to be careful because what causes the stronger student to do a better job of the project is, sort of, understanding that that's expected. And when we set up a rubric that says, these are the ways you get the marks, you present this data and that's how you're supposed to do it. Rubric up front – tell the students what they have to do, show them examples of projects and so on. A lot of our stronger students will go with, "What do I have to do here?" and they'll do a very good job of the middle of what ever standard you've set.*

Students Who Are Not in the Middle

Those students who fall outside the limits of the middle group are those whom she perceives as being the top-end students or the lower-end students. It seems to Martha that the top-end students in any class have more ability than their peers, are ready to engage in the mathematics she presents, and they demonstrate competence and a willing attitude to learn. These students can complete more challenging questions in each assignment and are able to transfer their knowledge and understanding to new problems. These are the students whom Martha feels she does not really have time, or the energy, to work with. They achieve good marks in the course, without any direct attention or teaching focused directly on their needs.

At the lower-end, there are students in each class who are not experiencing success in mathematics.

> *Most of us accept that there will be students who don't have success in our classes. ...*
>
> *There are always going to be a few people who just aren't with us. Some by choice, because they really don't want to put anything into, into the job a at hand. Some because they get confused and discouraged and give up. Some because it's just not going to happen ... They are not willing to sacrifice to that end, because it's not part of their perception. That's probably why they're not in the middle to start with.*

Martha is available before or after class to help students who are struggling, and remedial instruction is provided, but

> *at the high school level, students are not beating down the door to get extra help at school, I've found. So, it's hard sometimes to do much about the people who perhaps aren't in the middle but they're at the lower-end. They need extra help and they need more time and they need a lot more things.*

The Mathematics

Martha indicates that when she is planning to teach, she is aware of the abilities and attitudes of the students in her classes. With the middle group of students in mind, Martha reviews the curriculum documents to find a fit between the content

and her students. She translates this into language that she believes most of her students will understand and demonstrates examples of easy and medium difficulty on the board, for her students. If she has been successful in her teaching, her students will understand the concept she has tried to convey and will be able to tackle most of the assignment.

Although Martha does not rely exclusively on the textbook (she finds she has to supplement the text with her own resources), she does assign questions from the text for students to work on during the lesson and for homework. She finds that her textbook has been designed to include three levels of questions: A, B and C. The level A questions are the easiest questions; the B section contains those questions of medium difficulty and the C level questions Martha determines are the most difficult questions. When Martha is selecting questions for her students to work on, she chooses most of the questions from section A and B, and includes a few of the harder C questions.

> *That's probably the one place that you can challenge the upper end students, in that you can include questions that are a little more demanding, or a little bit more challenging. With the understanding that the, quote, middle group is probably not going to successfully finish on their own, but perhaps with some help they will understand at least what's being done.*

Teaching to the Middle

For Martha, 'teaching to the middle' is a "politically correct" way to teach that is inexorably linked to her expository style of teaching.

> *I think it is a politically correct way of teaching. I think when one tries to perhaps not teach to the middle there are, then there are, there's a big political problem with parents and students because their expectations is that they will have things explained to their satisfaction. ...I think there's an assumption that students will be successful, and depending how vocal the parents are, how much they understand about the programs, they can cause a lot of difficulty for teachers. For example, if you decide here's where my instruction is, very demanding, ask the students to try some very difficult things and if you assess them on the basis of whether of not they have been successful at doing this, and many of them have not been successful, so you produce marks that have a class average of 50 instead of 65, which the community is used to, the community is accepting of, is the word I guess I wanted to say there. Then I think you can have a lot of difficulty. It doesn't mean that your instruction hasn't been excellent, probably better than most, because you've been challenging the students, but it means that the public is not ready to accept that standard. [They] say, "No, these students should know what they're doing" and, "They should be able to get this mark", and, "Make sure it happens" and, "If you can't make this happen like that, there's something wrong with you and your method." There is a certain amount of political correctness and the smaller the community, the more likely this is to happen.*

Martha believes that this political pressure is very real for teachers in her community. Along with her community's widely held expectation that teaching is telling and

proffering explanations, there are also expectations for student achievement. Teachers will be challenged if these expectations are not met.

> *We always have a problem at the grade 10 level, when we bring in the grade 9 students, our Pure Math students, and it was true before we had Pure Math, we put them in Math 10, the marks in those classes were always lower , and we had students who came in with an 80% and who were now getting 60%. And this is, was always very hard to accept. Parents were not happy, they were sure that they had an honours student and now they didn't. It was quite a blow. Quite a blow to the students that, perhaps weren't just quite a strong as they thought they were. And it's always a challenge. There's always phone calls, visits to the principal, that sort of thing. Challenges to the exam when someone doesn't get a mark that their supposed to have. And so on. That's just one of the problems. I think that's one reason why we tend to do – sort of pick a middle ground and walk that ground.*

Martha believes that new teachers face these pressures as they begin their teaching career. As they become acculturated to their profession and their working environment, they find that the middle ground is often the safest place to walk.

> *... at first we don't know where [the middle ground] is. So new teachers often struggle with that. They're either too demanding or not demanding enough and eventually something happens, and it isn't that their instruction is flawed in any way, it's just that they've chosen a different place to aim their instruction. And after a while, I guess, I think most teachers want to push their students, but they know there has to be a reality. They have to come in line with other factors.*

Everyday, Martha is challenged to teach groups of students, who have wide ranging abilities. In her school, special needs students are integrated into age-appropriate classroom for social interaction. Martha must plan activities to encourage mathematical growth in these students, some of whom work with a teaching aide and are working at an elementary level. This, together with the wide range of student abilities Martha also perceives in her classes, presents an almost overwhelming challenge.

> *Now I know that theoretically you should be able to teach to the low-end and the middle and the high, all at once, and challenge the top-end and remediate the lower-end and keep all the people on track, all at once, but in reality in a classroom of 30 students, all with a lot of special needs of different sorts, this can't happen. It's an unrealistic expectation, that someone can do that. There are some times, that there are exceptional cases, where someone has been able to really challenge the top-end while dealing with everybody else, but most of us, most of us are human. It's not a realistic way to go.*

Not Teaching to the Middle

In Martha's experience, there are inherent problems associated with not 'teaching to the middle". Having listened to Martha speak about 'teaching to the middle' I have inferred that not teaching to the middle is associated with teaching in a way that is not expository, raising teaching standards to a higher than the middle level, and altering the teaching approach to include, for example, problem solving as

a way of investigating, discovering or creating mathematics. A major problem with not 'teaching to the middle' is the reaction of the students.

> *When kids come to us they have a way of seeing mathematics and if you try to change it, even in a small way, they get very upset with you, and they create a negative feeling in the classroom, when you're not producing the way they expect you to produce. And, if our instruction is aimed at some place else, or if your way of doing things is aimed differently they can become quite negative, because it's not what they thought was going to happen. Even if it might be a good thing, and even if they might like it and even if it might be productive for them, their first response is that it's different and so "I'm not happy with it".*

Martha has experienced this in Applied Mathematics 10/20/30 program, where she has tried to meet the challenge of teaching differently. She has found that her students are not receptive to a style of teaching and learning that calls for them to be self-disciplined and motivated, responsible for their own learning. They prefer completing worksheets and exercises and having Martha tell them what they need to know, to building their own mathematical knowledge through projects and investigations. They make their feeling known by creating a negative classroom environment and by completing the work at the minimum level.

Martha acknowledges that teachers who do not 'teach to the middle' may demonstrate teaching that is better than most, but feels that they must be able to defend their teaching with marks that meet the desired outcomes of their communities. By implication, not 'teaching to the middle' may result in student achievement that cannot be defended.

> *I've known teachers who've become embroiled in some very difficult political situations within their school. When their students aren't successful at doing what ever, and successful means giving them a good mark, so I guess if you can find some way to give them what's an acceptable mark and still be teaching them ... at some other level, then you would keep this pressure off.*

As our conversation came to an end, Martha commented:

> *You know I'm a little embarrassed that I'm perpetuating some of the stereotypes. But again there's a limit to how much you can change things. I think most of us – we always see those videos of those wonderful teachers, who can do everything and the kids love them and they go to the end of the earth for them. Most of us aren't like that. ... There are a lot of people like me, who are just trying to do the job the best way they can.*

The theme that pervades Martha's stories of 'teaching to the middle' is one of compromise: this is an approach to teaching to which she has conceded. She recognizes the negative aspects associated with teaching this way, and that teaching other than 'teaching to the middle' may well be *better than most.* Although Martha considers herself to be a specialist mathematics teacher, she seems to lack the skills, knowledge and motivation to pursue other routes to learning, or to find ways to facilitate the learning of all the students in her classes. Martha's teaching has been shaped and moulded by the political and social environment in which she works.

In the next chapter I will introduce Diane, another seasoned high school mathematics teacher. In contrast to Martha, Diane demonstrates confidence in her chosen teaching, and offers no apology for her chosen style.

CHAPTER V

Diane's Story

Background

Diane is a specialist secondary-trained mathematics teacher, who majored in Mathematics and has completed a graduate diploma in Education. She has been teaching for twenty-five years at the high school level. Most of her teaching experience has been in the courses, which have been considered 'academic' (Math 10, 20, 30 & 31). Since the introduction of the new programs of studies, Diane has been teaching Pure Math 10, 20 30 and Math 31. She has taught Math 13, 23, and 33 and will be teaching the Applied Math 10 program, during the current school year. Diane is respected as a leader in the Mathematics Department of her urban high school, where Mathematics is also offered at the Advanced Placement level.

Diane prefaced our conversation by saying that she would be speaking primarily about her experiences with the Pure Mathematics 10, 20, 30 program because it is a new program and its implementation is foremost in her mind. As this chapter unfolds I will reveal my interpretation of the words Diane spoke, during our conversation about 'teaching to the middle'.

Diane's Teaching Style

As I listened to Diane it became apparent that she favours a teacher-centred approach to teaching that is directed towards the whole class. She says that her lessons usually follow the same format each day and revolve around a presentation or lecture, which she has prepared. Her presentations involve explaining rules and procedures, while asking students questions, a technique that is designed to encourage students to work with her as she explains and demonstrates. This questioning is focused on eliciting student responses that will advance her explanation or demonstration, rather than on promoting whole-class discussions of the concept. As she monitors her students' responses, Diane is also evaluating the understanding of individuals and the class as a whole. During her presentation, students either make their own notes or copy Diane's from the board. At the conclusion of her presentation, Diane assigns exercises from the textbook and if time permits students may ask her questions or begin working on the assignment. Although she assigns questions from the textbook for homework, Diane does not review or answer questions about the previous night's homework during the lesson.

> *I'm finding that in all three of them, Pure 10, Pure 20 & Pure 30, there isn't a whole lot of time. So, if you start the class with homework questions from yesterday, you may get bogged down, which means you don't get the lesson taught that day. That can't happen because you only have [so much time] to finish the course. So, I tell students that if they need help or extra help or what ever, if I didn't get to it, they have to see me on their own time.*

When Diane teaches classes of more able students, she uses her class time a little differently. The lesson follows the format outlined above but, because Diane spends less time on her presentation, she finds that there is time during the lesson for students to ask questions and to begin the assignment. From time to time Diane will

collect some of the more difficult questions from the previous day's assignment. She remembered that one class

> *... tended to be on the upper-end or over 65% and I also had a class of 16. So, to me there was an opportunity then to spend a little more time with them when there was assignment time or have more time to work with them. ... I would say that this semester I had one Pure 20 class, which I would say were a lot better quality than I have seen. I really didn't have anyone at the real low end. So I tended to quite often skip steps in my presentation, and then allow a little more time for homework time and assignment time. And at that point sometimes I would actually take it in for homework. So, the upper end questions I would say, "OK. I want these two questions either done for tomorrow" or "Hand them in from yesterday's homework", because I felt that that class was a stronger class and they should be attempting the more difficult questions.*

While her teaching approach followed the same lecture format, Diane enjoyed the opportunity to teach students she considered stronger in mathematics. She was able spend time with students, answering questions and encouraging them, as they worked on problems, rather than spending all the class time on her presentation, as she usually does.

During the 2000/2001 school year, Diane will be teaching an Applied Mathematics 10 class. The curriculum for this course is rooted in a constructivist learning theory, as is the Pure Mathematics curriculum. However, this curriculum and its approved textbook require that student projects and investigations will be an essential pathway for students' mathematical constructions. Diane views the Applied Mathematics program as a replacement for the old Math 13/23/33 stream, and as such she views it as 'the non-academic stream', rather than a program that offers a different approach to learning mathematics. As she makes plans to teach this course, she says she will use her familiar teaching format: interpreting the curriculum and deciding the best way to present it to her students.

The Middle

Middle Students

The Alberta High School mathematics program streams students into courses based upon their ability and/or the mathematics they will need in their post-secondary education. In Diane's high school, students who have achieved over 80% in grade nine mathematics are offered the opportunity to take Advanced Placement mathematics in grade ten. Each year a few students decide not to take the Advanced Placement course and are registered in the Pure Mathematics 10 program. Students who meet the achievement standard, stay in the Advanced Placement program, while those who do not, usually transfer into the Pure Mathematics 10, 20, 30 stream..

> *They are in the Advanced Placement program, so they are in a special course by themselves, so what we are left with then are very few 80% pluses, from the pre-requisite course. So we get very few 80%+ students in our class and if we do it is by their own choosing, that they've decided not to go the AP route, and so we don't tend to see that upper-end, very often in our normal classes. ...*

The number of times you get someone with 80% or 85% that's not in the AP class is pretty – it does not usually happen.

In order to be registered in the Pure Mathematics 10, 20 and 30 courses, at Diane's school, students must have at least a 50% mark in the pre-requisite course (Mathematics 9, Pure Mathematics 10 or 20). Consequently, the students who are in the Pure Mathematics 10, 20, 30 classes at Diane's school usually have pre-requisite marks ranging between 50 – 80%. Thus, Diane identifies the students that she teaches in her Pure 10, 20 30 classes as the 'students in the middle'. (As might be expected, the students in the 'less academic' courses tend to be lower-end students, and those in the higher-level math courses, upper-end students.) In this middle group of students, Diane finds that there is a range of student achievement, which she attributes to the difference in students' inherent mathematical abilities and attitudes.

Diane finds that classes vary dramatically in character. Two, ostensibly, parallel Pure Math 20 classes can be quite different in composition and nature. A class is determined to be 'weaker' or 'stronger' after a review of the students' per-requisite marks. In her view, if most of the students' marks are at the lower end of the range (50 –65%), the class is a weaker class; if most are at the middle or towards the upper end of the range (65 - 80%), the class is a stronger class. Consequently, the achievement of the middle group of students varies from class to class. In addition, a class of students may, in general, be conscientious and hard working, or just the opposite. Diane has noticed that students who are in weaker or stronger classes exhibit fairly consistent characteristics.

I can compare [the weaker and stronger classes] *because I had a Pure 20 with 15, well 16 kids in the end, who were upper-end. So, if they wasted time or what ever, most of them would go home and still do their homework, or in their spare, or what ever. I really wasn't concerned because they were stronger to start with, and they would take work home. Where last year, I had a Pure 20, the same thing, but I had a small group, 15, 13 kids, but they tended to be towards the lower-end. And so, you know, I would give them classroom time, or what ever, and I'd be on their case, sort of, "Let's work", "Let's get going", "Let's whatever", and nothing would sort of help until I got frustrated and upset with them. But they were not the kind who would go home and then make up that time. And I really saw a difference between last year's group and this year's group - certainly a different classroom dynamic.*

Diane further classifies Pure Math students into upper-end, lower-end and middle students, according to their achievement in the course. Middle students, those achieving 65%, can be found in the weaker and stronger classes. Some of these students work hard and take initiative, while others show no initiative, do not take responsibility for their learning and waste their time in class and at home. This means that there are students, whom Diane feels have the ability to achieve better marks and might even be classified as upper-end students, but who demonstrate, by their actions, their desire to remain in the middle.

A driving force in Diane's teaching is a desire to see students achieve their potential. This potential will be different for each student; it is dependent upon the individual's inherent mathematical ability. In an effort to achieve this goal, she expects and verbally encourages students to get their work completed either in school

or at home. This encouragement works with some of her students but not with others. She finds that the middle and lower end students require this type of encouragement, but because she is unsure which type of student she is addressing, she finds that her form of encouragement sometimes fails.

> *That is what's so frustrating, because you don't know what* [type of middle student] *they are. And so sometimes you can push and push and push until you get, you know, get a comment or a back lash, or what ever, and they say, "Lay off", or "Leave me alone", or that kind of thing. And so sometimes you're not sure of how much encouraging you should do.*

Diane's teaching is formulated for those students who are willing and able to work with her, by doing their homework, asking questions and getting extra help when they need it. The ability and achievement of the 'middle' students varies from class to class, but generally those who are successful in the course, are those who meet Diane's expectations.

Students who are not in the Middle

As a result of the streaming that occurs at her school, Diane identifies the students in the Pure Mathematics classes as 'students in the middle'. These are the students, who, in general, can learn the mathematics she teaches and are successful in the course. Students who are in Advanced Placement or Math 31 classes are identified as upper-end students, while those in Math 13, 23, or 33 are lower-end students. Diane has not yet taught the Applied Math program, but, after talking with colleagues, she expects that these students will be similar to those she has taught in Math 13, 23, 33. In most of the classes Diane has taught, she has been able to identify students, whom she would call upper- or lower- end students.

Although Diane spoke mostly about the lower-end students in her Pure Math classes, her comments apply to other math classes she has taught. She finds it difficult to connect with the lower-end students. Generally, they have difficulty learning what she teaches, and consequently are often not successful.

> *I would say that the lower end, the 50 –55 student, quite often, as we go up in level, I would say tends to be less successful. So quite often they are coming in with 50 –55. Over all I would say that they are lucky to maintain a 50 standing as they go up from 10 to 20 to 30. Like, unless they really work hard, get extra help, do lots of homework, do what ever, they can't maintain that mark. OK? And I find that's the group we're not dealing with, kind of thing. I don't know how to motivate them. Some come in with 50 –55, or even 50 –65 saying, " I'm going to try it once". So, basically they just come in, sit in the desk, take a few notes, whatever, knowing full well that they're going to repeat the course. And so when they don't do very well, you know, that's the reason why, because they've already made up their mind very early. That's, that's hard because sometimes sets up a precedent around that group, that sort of feed off the rest of you. When they do get class time they don't use it, they waste it and I find that very frustrating, when you know that they will affect other people around them, kind of thing.*

The characteristics Diane has identified with the lower-end students in her Pure Mathematics classes are consistent with those she has found in students taking

the courses she says are less academic: Math 13, 23, 33 and, she suspects, Applied Math 10, 20 30. When we spoke, she had just taught a Math 33 class. Poor attendance and work ethic were mainly responsible for weak results in this class. Diane wondered whether these characteristics are part of being a low-end student.

> *I'm sort of wondering if that's part of being at the low end. They don't take enough initiative or what ever, to do the work on their own, or to get help, or what ever. Versus the kids who tend to be stronger, knows what it takes to be in that league and does things accordingly.*

Diane does not expect to see many "*truly upper-end students*" in her Pure Math classes, however, there are students whom she would say out-perform their peers. They are able to do this as a result of their attitude and work ethic. These students receive what is offered during the lesson and then take their learning to a "higher level" in their own time. Diane includes more difficult questions in the exercises she assigns, but she does not offer a solution to questions of this type, during the lesson. She expects that upper-end students will explore the textbook and work, in their own time, to find answers to these questions.

> *If they really are upper-end students, they can go from there, a lot of times. That's where their gift is. They can go on their own, much more so. Depending on who they are, they can take themselves further, they can push themselves further if they've got the initiative, the drive, the what ever. I think we let them show us they have the ability.*

The students who are not in the middle when Diane says she 'teaches to the middle', are those who cannot, or choose not to, meet her expectations. She expects all students to "*push themselves to their level*", to challenge themselves and to ask for help outside of class, if necessary.

The Mathematics

When Diane is planning her teaching, she begins with the curriculum, which she interprets and she decides the best way to present it to her students. This includes deciding how to explain and demonstrate procedures as well as selecting the examples she will demonstrate during her presentation. These choices are made based upon her knowledge of the students in her classes. Furthermore, she coordinates this knowledge with the standards (the standard of excellence and the acceptable standard) that appear in the Alberta Learning documents.

Recently, Diane has begun to plan for an Applied Math 10 class that she is teaching for the first time this year. She acknowledges that at the planning stage for this new program, which she has never before taught, she has difficulty gaining an understanding of the students, who will be in the class, and how they will behave, both of which are important influences on her planning. Although, she views this program as less academically challenging than the Pure Math program, she says that her approach to planning for this course is the same as for any course she teaches.

> *I actually did an Applied Math 10 unit on the weekend. I tend to look at the curriculum. What is the curriculum saying? Then I look at the textbook. Look at its presentation. Look at the textbook's examples and decide whether I'm going to model them. I very seldom use the examples out of the book because I feel that that is the student's other resource, that if they're at home and want*

to look at another example, then I haven't used the same example. So I tend to avoid using the textbook examples unless it's a really special kind of thing, and to make up my own, or do my own.

When choosing the examples to model, Diane

> ... *will begin* [her] *presentation with an easy* [example], *then hit the medium level and maybe do two or three or four at that level versus maybe pushing it to the outer level. I like to do the upper level when I think that either we have time for it, or I think I have people in my class who can handle that.*

Diane makes her decision about the number of each type of question to demonstrate, based upon her understanding of the abilities and achievements of the class as a whole. She emphasizes mathematics that is not too hard, and not too easy, by focusing on examples of medium difficulty during her presentation.

The textbook is an important tool in Diane's class. She finds that she frequently has to supplement it with her own resources, but she expects students to use it as a personal resource when they are away from her classroom. She finds that the textbook examples and exercises are most often set up in a hierarchy of difficulty, from easy to medium to difficult. The questions she assigns vary in number and difficulty, depending on her understanding of the abilities of the class as a whole, but the emphasis is on questions of medium difficulty. Diane will invariably assign some of the more difficult questions, but she does not expect that all students will be able to tackle, or solve these.

> *I usually leave the students to explore on their own and if they get to that in the textbook, because the textbook is very much organized with the exercises that start with the easy, then medium, then difficult. And I always assign difficult ones, but I sort of let the students explore those on their own rather than actually present them to the class.*

Whether she is choosing examples to model, or those for student assignments, Diane is conscious of the questions that have appeared on previous diploma examinations and the standards associated with the examinations.

> *You want to make sure that you know as far as depth and breadth of your examples the exam is certainly what you keep in mind, to make sure that you meet those needs and then anything else that you think they should know. And now after every exam, if there's a question on the diploma exam that I don't have in my notes, that I haven't covered, I will write that into my notes to help. To say, "OK this was on the last diploma exam. Maybe we won't need it. You know we never know when we will see it again. But, we need to be prepared for that level of question. That's something I've done all the time. ...*
>
> *We have to think that our standardized testing, our diploma exams are sort of aimed at 65%, as our supposed class average, or provincial average. And so I think that sort of dictates a lot of what we try to do in the high school mathematics program in particular.*

Diane chooses the content for her lessons, based upon her understanding of the overall abilities of the students in her classes. The content varies from class to class, usually emphasizes mathematics that of medium difficulty and is designed to offer a challenge every student.

Teaching to the Middle

For Diane, 'teaching to the middle' is related to reaching as many students as possible, while meeting the demanding standards of the high school mathematics curricula. Her role, as the teacher, is to explain and demonstrate mathematics so that the 'middle' students, who have the ability and attitude to be successful in the class, can understand and be successful.

> *But I think of my self as a teacher, my job is to definitely get the middle to where they need to be functioning and hopefully they function at that level and if I can get them further that's great. But certainly I don't want them to progress less than that. You know, because they are a middle student, I don't want them lower than that level.*

This means that Diane shows her students how to do the 'basics' – this means demonstrating examples of easy and medium difficulty – then she expects students to challenge themselves with the harder questions, taking their learning as far as they can.

> *As a teacher I think, if* [students] *can understand the easier and the middle and have a good knowledge of that, then I think they should be able to attempt the more difficult ones, but that also then, I guess makes them push to their level. As they are trying, you know, how much they can now bring to a question if they know the basics, how much they can use the basics to handle the more difficult questions and hopefully they can do that, they will attempt that.*

This expectation that students will challenge themselves and take their learning to their own level, indicates that Diane feels that 'teaching to the middle' represents a starting point for students to work from and as such encompasses 'teaching to the upper-end'.

> *... I think the upper end student, if they are really an upper-end student, can go from* [where the teaching ends] *a lot of times. That's where their gift is. They can go on their own, much more so. So to me, if I can get everybody to the middle, then depending on who they are, they can take themselves further, and they can push themselves further, it they've got the initiative, the drive the whatever. I think we let them show us that they have that ability.*

Diane has found that she has difficulty motivating lower-end students with this teaching style, whether they are students in classes she would categorize as lower-end, or are lower-end students in Pure Math classes. She described, in particular, the problems she encounters in classes that she recognizes as less academic. In the first semester of this school year, Diane taught one of the last Math 33 classes. In this class there were seven students who were taking the class for a second time, and the class as a whole suffered from poor attendance.

> *I would say, out of the first timers and kids that worked, I had maybe three, which I found very hard to work with, with the different groups in that class. And so I certainly focused on the three that I thought, were first timers were doing their homework, who would ask me questions. I made sure their needs were being met and I met the other classroom needs as, -- as I could.*

Not Teaching to the Middle

I asked Diane how she would teach if she were not teaching to the middle. She replied that her teaching style would remain the same, but the content of her presentation would change. She would still 'teach to the middle', but the middle would be in a different place.

> *Well I guess, if I had a lower end class then I think I would spend a lot of time on the basic kind of examples, and then maybe head to the medium, with very little emphasis on the more difficult. I think you'd still show them one or two examples of what ever* [concept you were teaching], *but I think you'd make sure you did a lot of the easy, instead of one or two examples I'd probably do five or six. I would try to make sure that that level was well understood before we went to the medium. And vice versa for the upper end. For the upper end I might do one easy, two medium and then three difficult, to show them where they needed to be working.- So I think the kind of examples would dictate what groups I was working with*

Would she teach differently is she were to teach to the top 10% instead of to the middle?

> *I guess, I would hope not*

Diane expressed great confidence in her teaching approach: she has taught this way for many years and believes that her teaching enables motivated students to be successful. She finds teaching students who are not motivated or have less ability more difficult: she does not alter her teaching strategies to accommodate these students, but expects them to meet her rigid expectations for student learning behaviours. In the next chapter, Steve presents a more relaxed and informal picture of his interactions with students, yet shares many of the characteristics, described by Martha and Diane, for 'teaching to the middle'.

CHAPTER VI

Steve's Story

Background

Steve is an experienced teacher: He worked for thirteen years with children at risk (*"juvenile delinquents")* and junior high school students. Five years ago he made the transition to teaching mathematics in high school. Today, Steve teaches mathematics in a large urban high school, where there is a focus on technology and science, and where the mathematics department is proud of their students' achievements on the provincial diploma (grade 12) examinations. Steve does not consider himself to be a specialist teacher of mathematics - his Bachelor of Education degree prepared him to be a special education teacher at the elementary/junior high level; he does not think it is necessary to have a solid understanding of mathematics in order to teach the subject. Within his school, Steve is recognized for his ability to connect with students: he offers tutorials outside of class time and works exhaustively with the graduating class as they prepare for their celebration. Steve's teaching assignment this year includes Pure Math 10, Applied Math 20 and Math 33; with the exception of Applied Math 20, he has taught these courses several times before.

Steve's Teaching Style

Steve says that his approach to teaching is similar to that of other teachers in his school. They meet regularly to discuss teaching strategies and agree upon common approaches, although there may be differences in the implementation of these strategies and approaches. Steve expressed the belief that teaching is not primarily about explaining rules and assigning lessons, yet when we spoke about the way his lessons unfolds, it became apparent that this s where the major emphasis lay.

In Steve's Pure Math 10 and Math 33 classes, his lessons follows a routine format, in which Steve is the focal point of the lesson, while he is teaching to the whole class

> *It's very much a routine. We have homework, what I call a homework quiz, at the beginning of each class, where on the board they do have three or four questions from the previous day's work. ... I make a test situation where I am testing whether they have done [the homework] or not. I will then go through the homework, with the students, answer any questions, and take as long as we need for that, to make sure there's clarity. Then, I teach the lesson and make sure I ask every single student one example, in the class. We go through the textbook. I'll pick 25 questions from the A, B & C's. And I'll ask every single one of them, so they have to follow and stay tuned into what I am doing. And then they have maybe ten minutes to start working on their own, with their homework. And that's pretty much the same for the other courses, except for the Applied 20, the new Applied courses.*

As students begin their homework, Steve allows them to work individually, in pairs or in small groups. At this stage of the lesson, he tours the classroom visiting individual students who seem to be having difficulties, offering further explanations.

I will try to spend time with them during the class, to work with them. It just depends upon the dynamics of the class as well. ... And for those four or five who are below, the tutorials are offered.

When teaching the Applied Math classes, Steve follows a similar format, although his routine is somewhat modified because of the nature of the activities in which these student engage.

A lot of the Applied involves the use of technology. Projects and hands on stuff. So it's difficult to give homework quizzes per se because the kids have to create, either with the calculator, enter lists, draw, input the graphs, sketch the graphs, whatever involves technology. All the questions would take 25 or 30 minutes to do by hand. So with them, I take a lot of homework in and you have to do what we call peer review sheets where they'll exchange papers and they'll have a rubric – designed by us, to go through and mark their papers, basically is what it is. ... and that comes in as a mark.

Depending on the objective of the lesson, sometimes the Applied Math lessons will proceed in a similar manner to the Pure Math lessons. At other times, the Applied Math students will work in pairs or small groups on the investigations and projects that are integral to this program. Steve finds that

[the Applied Math] *course is quite rigorous, if not more than the Pure, but in a different way because of the technology and the applications the kids are using. ... Those who get it, get it right away, and those who don't, I spend quite a bit of time with. In fact a lot of our time is spent at lunch- time doing tutorials with those kids.*

I asked Steve what he meant when he said that he "teach[es] the lesson". He replied that he explains the concepts and demonstrates examples on the board and students copy or make notes into their notebooks. Part of his explanation may include demonstrating the use of concrete materials and/or representations to the whole class, who then practice using them. Although the classroom routine may vary between the two programs, Steve's understanding of his role in the classroom does not.

I'm a facilitator. I understand the concepts and the curriculum and I'm trying to get it across to them so they have an understanding of it. ...They don't believe you when I tell them they're going to need [the mathematics] in a few years. So I just encourage them. Be positive. "You can do it. Anyone can do it."

It is interesting to note Steve's use of the work 'facilitator' because it has become synonymous with the role of the teacher in reform-oriented classrooms. Here, Steve is using the word to describe his role in a more traditional classroom. When Steve is teaching, he endeavours to ensure that there is "*clarity*", that every student comes to a clear understanding of the mathematics he has taught, so that they can tackle the homework assignment and be successful. However, he is a realist and knows that not all students will be successful.

I expect the students will take as much as I can offer and do with it the best that they can.

In an effort to ensure individual student understanding, he ass each student in the class one question from the text before allowing the class to begin the assignment. The questions, selected from the A, B and C question sections of the textbook, cover

the range of difficulty offered by the textbook. Steve indicated that this is also a method of maintaining control; keeping students involved and interested in the lesson. Finally, this procedure acts as a check for the effectiveness of Steve's teaching. If students have difficulty at this stage of the lesson, he knows that he needs to provide further explanations and/or demonstrations. Monitoring student responses is an important aspect of Steve's teaching. It enables him to decide which students would benefit from some one-on-one attention, and to tailor his teaching to the needs of his class, as he perceives them.

> *It depends on the dynamics of the class. You do change your teaching style for each class. And it also helps if you're* [teaching classes] *sequentially. You'll do something different in the second class that didn't work for the first class, and you'll likely try something different.*

Steve has determined that his teaching practices are successful. Most of his students pass his classes, and his school has good results in the grade twelve diploma examinations. Steve also measures success by the attendance record in his classes and by the number of students who are willing to seek extra help from him during the lunch hour.

> *If I get 95 – 98% attendance rate then I've been very successful. It shows the kids want to be there.*

These measures of success lead Steve to believe that students quite enjoy coming to his classes. He reasons that this is because they

> *like the pattern and they like the routine.*

For himself, Steve finds that his way of teaching provides personal benefits:

> *The class time is manageable and* [the class] *seems to be running well.*

The Middle

Middle Students

When Steve speaks about 'teaching to the middle' he is referring, in part, to the students he teaches. The students form the majority of any class, and in this sense Steve equates 'middle', majority' and 'most' when he speaks about the students. He thought for a few moments before speaking about the characteristics of most of the students in his classes.

> *For the most part I find that the kids in the middle are the ones who show up every day, work hard, but have a difficult time with math. And so no matter what they do, they're going to get 65%. You know, you can throw out that number and it's frustrating to the, that they work so hard and they put in all this effort and they can't be successful. Well, successful, they are successful in what they do, but not as successful. The middle group likes to be teacher-led and likes the instruction and then some of the one-on-one. For them to be let loose, to explore and so on, they don't' want or like that. They want guidance and the structure. So the kids in the middle, they work hard and they need to be successful.*

Students Who are Not in the Middle

Since most of the students fall into the middle category, there will be a few who are at the lower end and one or two at the top end in each class. Because of the

pre-requisite marks required for registration, Steve feels that the students in his classes have the potential to be successful and are in appropriate classes.

> *I think the ones that don't succeed are just making a choice, and I'm not talking about an ability choice. In making a choice in not doing their homework, not doing or coming for extra help, and not making an effort to understand.*

In expressing this view, Steve is confirming his belief that almost all students can learn to think mathematically. Whether they do or not, he feels, is a decision taken by the students. At the upper end, Steve believes there are some students who have natural ability for mathematics. Some of these students work hard to achieve their results, but

> *some of the upper end kids have never done anything, homework-wise, review, the whole bit. They just get it. It's very frustrating for the middle kids.*

The Mathematics

When Steve speaks of 'teaching to the middle' he is also referring to the mathematics he teaches, which is determined by the standards associated with the provincial achievement test and the diploma examinations. Most of the junior high and senior high school students that Steve has taught will all have written or will write achievement tests or diploma examinations. I asked Steve about the impact of the provincial testing upon his teaching.

> *It's what drives it. It's the whole thing. ... I don't know of any place else where achievement tests drive the final results of where we end up in life. ... Numbers are important to the school board, and the parents and the kids and so you teach to the major group in the middle for their understanding.*

Before Steve became a high school mathematics teacher, he taught mathematics for several years at the junior high level. There, his goal was to have as many students as possible reach the acceptable standard and the standard of excellence. In the heterogeneous groupings of junior high school students, Steve found that

> *probably, I would say, 70% of the students in the class are in the middle group. 10% being the upper end and 10 –20 % being the lower end.*

Since Steve plans his teaching for the majority of his students, the achievement testing standards are reflected in, or are a reflection of, Steve's experience of teaching junior high mathematics. He found at grade seven, eight or nine,

> *predominantly, 65 to 70%, I think, would be the average mark in a junior high class, where you teach to the middle. Some of the weaker kids, 50 –65%. There's a very few with 80s, 90s, I found when I taught, because of my teaching style.*

Steve suggested that he found 'teaching to the middle' in junior high school was an approach, which facilitated the largest number of students achieving the 'acceptable standard', if not the 'standard of excellence'.

In Steve's high school, in-coming grade ten students are streamed into mathematics' courses according to their achievement in mathematics in grade nine. Students with a mark of 65% or higher are placed in the Pure Math stream; those with 50- 65% take Applied Math, and those whose marks fall below 50% will pursue Math

14/24 or join the IOMP classes taking Math 16/26. Incoming students with high achievement in grade nine mathematics are placed in Pure Math 10E, '*an academic challenge type class*', which continues with Pure Math 20E and 30E.

The students that Steve currently teaches will take diploma examinations at the conclusion of their grade 12 mathematics courses, unless they transfer to a non-examination mathematics stream (Math 14/24 or Math 16/26). The provincially mandated standards – the acceptable standard and the standard of excellence – are exemplified for teachers in documents distributed from Alberta Learning (see Appendix A). Most students take the courses, which lead to writing diploma examinations – Pure Math and Applied Math.

The impact of the achievement tests and diploma examinations on Steve's teaching are obvious from his comments, which are peppered with references to the standard of excellence and the acceptable standard. He plans his teaching to encompass the weightings suggested by Alberta Learning (2000) and frames his teaching with these terms.

> *When I went to high school, and I taught more to the standard of excellence, than I did to the acceptable standard, I [was] asked to tone it down and teach more to the acceptable standard than to the standard of excellence.*

Steve's junior high teaching experience led him to believe that the upper-end students would be in the Pure Math classes; he expected that they would be able to work at the standard of excellence. His high school teaching experiences led him to determine that teaching to the standard of excellence, was not 'teaching to the middle' but 'teaching to the upper end'. Over several episodes of teaching Pure Math 10, Steve has observed that, in spite of this request to tone down his teaching,

> *in the Pure Math classes, I do teach more to the standard of excellence than to the acceptable standard, because they are in that upper group, I'm not teaching to the majority of the middle. The majority should be in the upper end.*

Steve expects that the majority of Pure Math students will be able to work at a level higher than the acceptable standard, and he frames his teaching with this expectation. He has a different experience when he teaches the Applied Math program.

> *I'm probably teaching to below the middle in the Applied because of some of the concepts, they're quite rigorous. A lot of the kids don't have the technology and you have to find a way to work around that. ... A lot of the kids are in the Pure Math who should really be in the Applied, but it's a futile course for them because it doesn't take them anywhere.*

When he expressed these ideas, Steve was highlighting the difficulties he has speaking about the 'middle' in relation to provincial standards. In one sense, he believes that students in Pure Math classes represent the 'middle to upper end' of students in the entire age range. On the other hand, he teaches to the middle group of the Pure Math (or the Applied Math) class, which may actually be above or below the middle. Significantly, Steve plans his teaching to accommodate the expectations of the test that these students will take at the end of their high school math course, and that the language of the achievement and diploma examinations has infiltrated and shaped Steve's teaching practice.

Teaching to the Middle

When Steve moved from the special education environment to whole class teaching, he was faced with the challenge that all classroom teachers have to meet. Namely, finding a way to teach large groups of students, with wide-ranging abilities, while keeping the teacher's workload within manageable limits. Initially, he planned for each student individually and spent "*enormous amounts of time with each student*". He attempted to continue teaching this way but he found that it was impossible because "*the work-load was so extensive*". Consequently, Steve formulated the teaching practices he uses today. He says that he

> *is 'teaching to the middle',* teach[ing] *to the middle group, for their understanding ... interpreting the curriculum and presenting concepts so that most students can understand them, and be successful.*

In high school,

> *you're supposed to have the middle group in the right stream, the upper end in the right stream and the lower end. And if you do have the right kids in that group ... you teach to the middle of that, so you do get the majority of the kids to be successful.*

He acknowledges that

> *the upper level kids are at a disadvantage as well as the lower level kids, because you do teach to the middle ... and unfortunately the four or five of them who are up a level, and they get it right away, we don't provide them with any extras. For those four or five who are below, the tutorials are offered.*

Steve has struggled to find ways to adapt his whole-classes teaching so that he can accommodate the needs of some of the students who are outside the middle group. Usually this means finding ways to help those students who are having difficulties rather than those who are finding the work easy. One strategy he uses is to work with students one-on-one, in pairs or small groups; providing students with extra help and explanations, when there is time after he has taught the lesson. A second strategy is to offer tutorials during the lunch hour for those students who need extra help. Steve finds that these tutorials are well attended, especially by Applied Math students.

Reflecting upon his teaching experiences at the junior high and the senior high school level, Steve's commented that he believes the practice of 'teaching to the middle' is very common at the junior high school level because

> *there's no streaming – all the students are being taught the same curriculum.*

At the high school level, it is common, too, even though students are streamed into different mathematics programs. He speculated that this is because

> *even in the streamed classes there is broad range of ability and students are placed in inappropriate math classes.*

In spite of the short-comings he associates with 'teaching to the middle', Steve says

> *I don't think we have a choice, right at the moment. Like I say we want the majority of kids to be successful ... Once I got into junior high I found the work was so extensive, that this to be the best method for me, to get through everything that they needed to do and still assign marks and get everything*

back. And I also find that by 'teaching to the middle', the kids aren't scared of the mathematics anymore. It's so nice when the kids go, "Oh, I got it. I understood that!" and when they say they enjoy coming to class.

Not Teaching to the Middle

When I asked Steve to consider how he might teach if he were not to teach to the middle, he spoke about adaptations to his usual teaching practice. Consequently, if he were to teach to the top 15% of the class

> *my pace would be quicker. There would be less checking for understanding. In the sense of "Is there anyone who doesn't get this? Say so please." There'd be less review. My knowledge or my thoughts would be that "You already have this base. We're going to expand upon that base without going back to it." And my expectation for the quality and quantity of work would also be different. So when I mark exams to the middle, there's leeway in my marking. There's point five and I'm looking for the successes.* [If I were teaching to the top 15%.], *they'd have to show me where they're at, I guess.*

This is very similar to the description he gave of his teaching experience with an elite Pure Math 10 class.

> *In stead of giving them extra homework or what ever I just teach more concepts than we're supposed to, probably introducing them to the Pure Math 20 a little earlier, and my expectations are a little higher for them on tests and other indicators.*

I asked Steve whether he had considered other teaching approaches and if these might provide alternatives to 'teaching to the middle'.

> *I have tried all that stuff that comes out and goes around and around, but I'm resistant somewhat to that, because I haven't found it to be successful for the middle group. I find it is very time consuming, and I find the middle group likes to be teacher led.... I don't know how it can change, unless you stream even more and do diagnostic testing and have five or six different streams ...You know what, you'd still have a middle to teach wouldn't you? Yeah, you'd still be teaching to the middle'.*

Steve's 'teach to the middle' stories reveal his commitment to his students, and his apparent inability to use his skills to move beyond his predominantly transmissive mode of teaching. He recognizes the negative aspects of 'teaching to the middle' but subscribes to the philosophy that he should do what is best for the majority of his students, rather than the individuals. Like Martha, Steve's teaching has evolved as a result of the influences of his work environment, and his view is somewhat jaded. Sara, the teacher whose story is in the next chapter, is a contrast to the previous three teachers: she is inexperienced and, her philosophies and beliefs are still in development.

CHAPTER VII

Sara's Story

Background

Sara is young and vivacious. She graduated from her Bachelor of Education program just over three years ago; a degree she pursued after completing a Bachelor of Commerce program. She majored in Mathematics and she considers herself to be a specialist, secondary mathematics teacher. Her teaching career began in an urban junior high school. After three years, she transferred to the large, urban high school where she teaches today. This school, with almost 2000 students, offers a wide range of courses and programs (including the International Baccalaureate), emphasizing excellence, which, it suggests, is demonstrated by the higher than provincial average on diploma examinations. When we met for our interview, Sara had just completed her first semester of high school teaching - an assignment that included Pure Math 10 and 20, Applied Math 10, and Math 14.

During our conversation, Sara reflected upon her teaching experiences, moving back and forth between her time in junior high and senior high school. Although Sara has only limited experience of teaching, she spoke enthusiastically and confidently about teaching at the high school level. Her frequent meetings with other mathematics teachers in her school to discuss issues and strategies have prompted her awareness of the issues and challenges facing teachers in her department. In addition to the regularly scheduled meetings, teachers in her mathematics department are working collaboratively outside of the classroom on an Alberta Initiative for School

Sara's Teaching Style

As I listened to Sara speak about teaching at the junior high and high school levels, it soon became apparent that she is a passionate teacher, who is refining her teaching style as she gains experience. Over the course of two hours, she referred repeatedly to the way in which her teaching was developing, from the early days where she was struggling to keep up with all the demands placed upon her and when she found she was a slave to the textbook, to her current experience, as "*a more experienced teacher*". Today, she finds her teaching includes

> *teach*[ing] *in the traditional sense of the teacher standing up there and directing* [and times when] *we do investigations and I'm totally helping and sort of teaching that way.*

In Sara's experience, she finds that she uses a more traditional style of teaching (she calls it "*more rote teaching*") in the Pure Math classes. In these classes, she is the focus of the lesson, as she explains and demonstrates concepts on the board. Students copy her notes and then work through an assignment from the textbook, in small groups, pairs or individually.

> *Unfortunately the Pure curriculum is a lot more chalk and talk. Right? I stand up there. I give my spiel and then, you know, we try to be interactive with the kids, but honestly, especially at the school I'm at, the kids are so good in the Pure classes, sometimes it's like I'm up there by myself. It's like, "Hello! I'm here!" Like, I'm kidding around and I'll try to make some jokes, and the kids*

will interact, but generally they are so quiet and they just sit there and watch and stuff like that. And you know we don't really necessarily have that much time to do too many, fun, interactive, investigative type things because of the curriculum.

In contrast, Sara finds her teaching is quite different in the Applied Math classes. Although there are times when she leads the class from the front of the room (usually during a review session), she finds that most often she engages students in investigations, in small groups or pairs.

In the Applied Math, a typical lesson varies with what we are doing. Like – we did an investigation on the Sine Law. I hardly did anything that class. Like, I hardly taught anything. I said, "OK we're going to do this and you guys go to this page and do [the investigation on the page]. *Here's the rulers, here's this." And they got into pairs and they, they got on with it. And I just circulate. And I'm totally helping out and sort of teaching that way, but I'm not standing at the front of the room. And there's other lesson where I do sort of do more at the front of the room. We're just starting the Trig. unit, and I think that's a bit more teaching. ... But next week we're going to build the clinometer. So hopefully it's nice and we'll go out side and measure the heights of some buildings using it. It'll be fun I think.*

One of the results of her different styles of teaching with the two math streams is that she is beginning to see the value of investigative activities for all students, not just those she perceives as being the weaker math students.

I think that kind of teaching, that kind of activity appeals to everyone, because in a way everyone's understanding increases.

Sara is excited by the possibilities offered by teaching with investigations. She has used an investigative activity once in her Pure Math class. At the suggestion of another teacher in her school, she used a student investigation at the beginning of a Pure Math 20 unit on paraolas.

One of the teachers gave me this suggestion. He just has them make a table of values like $X^2 - 3X + 2$, *something like that. And he'll start them like he'll say, "Right, we're gonna make a table of values. We're gonna solve for y." And he gives them the X-values and the domain so they don't have to mess around with that. And he gives them a piece of graph paper and tells them to make the biggest parabola they can. So they have to make the scale. You know, actually it was really good. And I asked them questions, at his suggestion. "What is the domain? What's the range? Is this a function? What is the vertex, what's the minimum or maximum point?, and we haven't even touch on this unit yet. And you know "What's the line of symmetry?" And some of the kids just automatically knew and some of them said, "What's a vertex?" And then of course you've got ESL* [English as a Second Language] *kids. And we haven't even talked about any of this yet ... and they caught on and some of them even began to ask each other questions. It was a good exercise actually, I thought. So it was an investigative type of thing that I wouldn't necessarily have thought of. So I was glad that teacher suggested it to me. And now that's half the concept, or a lot of the stuff they have to grasp in the whole chapter and we've sort of done it before I've even taught it!*

One reason for her limited use of investigations in Pure Math classes is that she feels that the curriculum leaves little time for investigative activities, even if there is an expectation in the curriculum that these will occur. Another is her comfort level with teaching this way.

> *Not that the Pure stream wouldn't benefit from that, they would. ...There are some suggested activities for more applied things in the Pure as well. And I think as I teach more I think I might try to take some of the ideas from the Applied and say, "Oh, we'll take half the class in the Pure and do this", or something like that. But it's not -- you know there's so much curriculum that I think there isn't a lot of time to sort of play around and say, "Oh we're going to investigate this". But as I teach a few more times, I think I would like to try to do more of* [the investigations]. *Get out of my comfort zone.*

As we spoke, it became clear that Sara has different expectations for students and herself when she teaches the various mathematics programs: "*You've got a different clientele in different classes*". She anticipates that Pure Math students will come to class prepared and ready to learn. While in her Applied classes she finds

> *I don't mean to generalize, I think a lot of them struggle with math. Many of them have difficulty getting there, period. They might have different backgrounds, or whatever. Like a lots of them have difficulty getting there on time. Some of them have difficulty getting there, period. You know some of them don't come with their pencils, or their calculators. ... I just kind of know, "OK this is what I am going to expect".*

Sara finds she responds differently to students in the two classes, too. When students in Applied Math classes arrive late or without the necessary equipment,

> *I'll go, "OK, here's a pencil and I have extra calculators. ...I always have my extra scientific calculators at the front. You can borrow these". And I just kind of know this is what I am going to get.... And I try to be a lot more motherly or I try to be very, very kind to those kids.*

She is less tolerant with students in Pure Math classes.

> *But with the Pure kids, it's a lot more "OK, this is what I am going to expect ... I expect you guys on time". I'm a lot more harsh, you know, just because, have different expectations for them.*

Sara highlighted her differentiated approach to students in different mathematics programs when she recounted a story about teaching a student in a Math 14 class. This was the only time Sara spoke about teaching Math 14 students during our conversation.

> *I had one* [student] *who was repeating Math 14, right. Not because he never came to class, but because he did not get it. ... He was like the first day, first or second day, he put up his hand. "Ms. Smith, I'm in grade three level math." And he had this little blue hat on, like a ball cap, and he's been diagnosed with* [mental illness], *but I think his diagnosis has changed quite a few times and he's just had a rough background. My heart melted, he's just so sweet. And I worked and worked with that kid, and he passed. Like he at some point was doing fractions, you know, on his own and he was calculating the volume of a sphere, you know just using* [the formulas]. *I'm sure had no idea really. And when it came to the final exam. Like on a quiz he would get his 60 or*

70%. When it came to the final, he just looked at it and said, "Ms. Smith, I don't know anything." And I said "That's OK" and I marked his paper just like everyone else's and he came out as a 50 and he passed. And I was, you know, so thrilled. And he would never have made it perhaps if I hadn't worked so hard with him.

Sara's teaching style is in evolution. When she speaks about her developing teaching style she says:

I guess you kind of play around and you get ideas, and sometimes it's not always as perfect as you'd like it to be, especially at first, but teaching's not going to be perfect. No I don't think it's ever going to be perfect.

In her early days as a student teacher, she was "*told more than once that* [she]*'d be teaching to the middle a lot*"; she found that her approach was quite teacher-centred and heavily reliant on the textbook. She directed her teaching at the whole class and attempted to spend time with students who were struggling ("*the little guys at the bottom end*"), but found little time to challenge the stronger students ("*the bright lights*"). Three and a half years later, her teaching is in flux: a mix of traditional and non-traditional teaching (Raymond, 1999), and her conception of teaching is changing, as she tries on the robe of 'guide to and facilitator of' student learning.

The Middle

The Mathematics

Sara says that she has no option but to teach the curriculum. In her early days as a junior high school teacher she used the textbook as her guide; she covered the textbook material using the methods suggested. Soon, she realized that this was not a true representation of the Alberta curriculum and discovered that she had

gone way beyond the curriculum, which was fine because we had the time and I don't think I injured any of the kids.

Now, a high school teacher, she finds that she is

always looking at the curriculum, and I don't necessarily have as much time as I did in junior high.

Sara refers to teacher resource manuals (T.R.M.s) and other support documents, including the teacher's textbook.

I go by these a little bit, in fact, quite a bit. In fact those are what my notes are based on, like I'll add extra small examples because sometimes they just have these three big ones, and then they are supposed to know everything. You go, "OK, do your assignment" and they're like, "We don't' get it". So I pick some out of the textbook and sometimes I'll get started by explaining the first couple of questions, even. I'll say "OK let's all open our books and we'll do questions one and two together", sort of thing.... When I've taught it once, I'll know where they have problems and I can pick [the questions] *that way.*

When Sara is selecting questions for students to answer as part of their assignment, she usually chooses questions from the A and B sections in the textbook.

I don't really do the C. It was suggested to me "You don't want to, you want to avoid the C questions" and again as I teach more I'll figure out more. I think once in a while I'll assign a C questions. In fact, I did for this one section, on exponents, which was kind of grade nine review. I assigned a couple of C

questions. It just depends on the concept. For some curriculum things the C questions would be very hard for everybody, Do you know what I'm saying? Like for a particular concept the standard of excellence might be quite easy for everyone.

The standards associated with the provincial testing in mathematics impact the level of mathematics that Sara teaches. She is participating in the AISI project undertaken by the teachers in her department; they are identifying, with the use of stickers, which questions and examples in the Pure Math textbooks are illustrations of the acceptable standard and the standard of excellence. Sara cannot understand why this has not been undertaken before.

It's kind of embarrassing. Why wasn't it done before? ... I think a lot of teachers go by the textbook, or by what they think the students should know, or by what they've always taught. This way they'll know what the standard is.

Once this project is complete, all the mathematics teachers in her school will be able to use the stickers as a guideline when selecting questions for students to work on. Sara thinks it is important for the Pure Math students to understand what the difference is between the acceptable standard and the standard of excellence.

We even talk, like when I'm, teaching a lesson, I'll go, or if I'm giving some examples, I'll say, "This is the standard of excellence. Only 4 or 5 of you should be able to get this". Then they all might think it's difficult or it's easy, and that kind of think. With the Pure it's important, it makes them appreciate that you have to teach it, and that you're not just making it up to day.

As with her expectations, approach and response to students, Sara treats the Applied Math students differently.

I don't really talk about the curriculum and the standards with the Applied. I don't really bring that up.

The Students

Sara says the middle students are those who form the bulk or most of any class. It is relatively easy to identify this group because

you can just kind of tell where the bulk of the class is going.

In high school almost all students are in the middle group because of the streaming that occurs; as many as twenty-five out of thirty students may comprise the middle group in a class of thirty. In some high school classes the middle group seems to be the entire class.

When Sara compares two ostensibly parallel math class, she finds that the middle seems to vary from class to class.

All classes are different. Sometimes there will be times when you'll go, "Oh, this class seems to be doing well" … and other classes seem to find it harder. So, yeah, there is [a middle], according to the class, but even in a bright class you've still got a middle, right, and even within a lower class you've still got a middle.

Sara says it is hard to speak about the characteristics of the middle students, because each class is different.

They're not really the over-achievers, and they're not really the failures. ... They're the ones who just sort of get it.

Teaching to the Middle

For Sara, 'teaching to the middle' is related to a teacher's response to the demanding requirement of teaching groups of students with wide-ranging abilities and interests in a limited amount of time. As with Steve in the previous chapter, Sara, who taught in a junior high school for three years, says that she believes that 'teaching to the middle' is more common in junior high schools than in high school, because of the wide range of students in each class.

> *In junior high school for instance the classes are not quite as streamed, as they are in high school. I don't know if you necessarily taught to the middle all the time, but you have, you know, the majority of students are perhaps in the middle range and then what you can do, sort of, from there, you sort of have to go round and really help those little guys at the bottom end, those little stragglers, and then the ones as the top, you have to try to challenge those. So it's all over the place. ... In junior high you have kids who can barely add, you know, in a grade nine classroom because in our school system they're passed along, passed along. So you have kids who may never have passed, maybe, a class since grade two, and then you've got kids who have gotten 90s all the way through, in grade nine class. So you kind of have to go, I guess, according to the class, but you have to start somewhere, so you start in the middle.*

Since Sara started teaching at high school, she finds the streaming that occurs when students enter high school results in the range of student abilities in each class being narrower.

> *You still have a lot of levels, but maybe not as much as in junior high...There's still a middle. And there's still kids who are weaker, too. But it's not, maybe, necessarily, quite as, they don't' stand out quite as much as in a junior high class.... In junior high you're going to have about twenty out of thirty, who are in the middle, and you've got five bright lights and your five strugglers. .... In high school, there's maybe twenty-five who are in the middle and who learn what you teach, and the range isn't as wide.*

Sara says that 'teaching to the middle'

> *just sort of means, you know, that the middle, figure out what the middle of the class, what their ability level is. Start there and then try to maybe modify for above and below levels.... I don't know if it's something you set out as a goal, "OK, I'm going to teach to the middle", but I think you proceed with your lesson and then you kind of improvise according to what they need.*

Sara determines the middle of each class by looking at marks from previous courses and by

> *testing and quizzing. But just even in the first day or two you can tell who the bright lights are and who's going to put up their hand. And just going around helping students, I find I can really pick up on what they know. And how strong they are, just, just by the questions they ask, you know, and oh they're stuck on number two and everyone else is on number eight, or they're mid-range. You can just tell where the bulk of the class is going, I guess. ... Classes do vary, but even in a bright class you've still got a middle, right, even with a lower class, you've still got a middle.*

I asked Sara to tell me how she modifies her teaching to help those students who are not in the middle, or do not form the bulk, of the class. She said that most often this would mean finding ways to help students who are at the lower end of the class.

> *It's easier to modify for the lower end, I think. [I give] less questions, depending on the class, you know, fewer questions, and help right away. As soon as you give an assignment, you know this child or this student is going to struggle with this, and you just zone in. "How are you doing? Let's go over this. Let's get out your book". You just help them more. So more one-on-one help.*

Sara uses this approach in all the classes she teaches to provide support for students who are having difficulties with mathematics. She says that she does not have to provide extra challenge for the upper-end students in her classes. In particular,

> *in the Pure class ... I think the bar is pretty high to start with.*

If she did think about modifying for the brighter students

> *I guess I'd give less questions, depending on the time, depending on the class, maybe fewer questions right away.*

Not Teaching to the Middle

Over the two hours that we spoke together, Sara began to wonder whether all of her teaching could be called 'teaching to the middle'. She felt that her teaching had changed in some ways since she had moved to her high school. When she reflected upon the teaching she engages in when she uses activities, projects and investigations, particularly with the Applied Math class, she said,

> *I think that kind of teaching ... I would say that isn't teaching to the middle. That's just teaching to everybody. I think everyone gets something out of it. And even the bright lights, they might go, "Oh this is so easy", or "This is what we're doing", they still have to work at it. And the kids who were struggling before, they might, some of them click in, and even if not now, maybe later on. So I don't think that is teaching to the middle.*

When I asked Sara how she might teach the top five-percent of a Pure Mathematics class, she responded by referring to her familiar approach to teaching. She would engage in explanations and demonstrations, but

> *would probably just move things a bit quicker. We could move to a bit higher level. I could skip steps. I wouldn't necessarily have to show every step, because those kids would get it. But, also we'd probably have more time and then we could do some fun things.*

When Sara responded to my survey, she indicated that she did 'teach to the middle'. Two months later, while we engaged in a conversation about the phenomenon, Sara's belief that she taught this way was shaken. Towards the end of our conversation, she commented *the middle changes all the time, it depend on the class, the grade, the group of students ...you know, maybe there isn't really a middle.* Later I received an email indicating that, as a result of our conversation, she had concluded that she does not 'teach to the middle'.

It appears that Sara is passing through the process of acculturation to teaching, described by Martha. She is experiencing conflict between the model of teaching she

experienced as a student (and has seen her peers engage in), and a model for teaching and learning that she is attracted to and which she sees will provide learning opportunities for all students. Judith, the teachers whose stories form the next chapter, has similar but distinct experiences.

CHAPTER VIII

Judith's Story

Background

Judith says she is a specialist, secondary mathematics teacher. She majored in mathematics and has completed a Master's degree Education. Now in her seventh year of teaching, Judith has returned to Alberta to work in a large rural high school, which offers a wide range of academic and non-academic educational opportunities to it's diverse student population. Judith's teaching assignment this year includes Pure Math 10 & 20, Applied Math and Laws 19, a life skills class for students who are classified in terms of moderate mental disability. Outside the classroom, Judith coaches her school's junior-girls' basketball team.

As an experienced teacher beginning a new phase of her career, Judith is re-experiencing some of the challenges faced by newly qualified teachers, as she comes to grips with unfamiliar curricula and a new working environment. In Judith's first six years of teaching, she worked almost exclusively with aboriginal students, many of whom come from educationally impoverished home environments and suffer from a variety of educational handicaps. This year she is adjusting to teaching students from relatively enriched educational backgrounds. When Judith completed my initial survey she indicated that she "*sometimes teaches to the middle*"; as we engaged in conversation, I attempted to uncover what she meant by this.

Judith's Teaching Style

Judith says her teaching approach is traditional, direct teaching "*with perhaps a bit of constructivism thrown in*" and is aimed primarily, at the whole class. This means that she explains rules and procedures at the chalkboard at the front of the class. Judith's belief, that it is important to learn the basics before attempting to solve problems, is translated into her step-by-step approach to teaching.

> *You know mathematics is a subject that lends itself very nicely to the obvious. You know, if you follow this procedure, you can't help but come to the 'right' answer.*

She expects that her students will learn what she teaches and then use this knowledge to answer the exercises that she assigns. Her teaching style is modeling on the teaching she experienced while in school. Although she does not meet regularly to discuss teaching strategies with her school mathematics colleagues, she is confident that their styles are similar.

Judith has a personal interpretation of direct teaching, which she says is a modification of the traditional 'chalk and talk' approach. She encourages students to participate in her "*lecture*" by asking questions during her explanation and using her students' responses to advance the explanation.

> *I try to let the kids direct some of [the explanation], within the context of the classroom. And that's what usually evolves in the conversations that happen through my direct teaching. ... The direct style that I use is in conversation with kids, and so what the kids come up with in terms of their own thinking determines what happens at the board, in terms of the explanation.*

Thus, Judith's teaching plan is flexible; she relies on and is responsive to feedback from her students. However, she did reflect that, while this approach allows her to orient her teaching towards the thinking of the students who are vocal, it excludes students who do not participate in the 'conversation'.

Although Judith's patterns of explanation vary from class to class, Judith finds that her lesson follow a predictable routine. A typical Pure or Applied Mathematics lesson would see her

> *take up the homework from the day before, launch into the explanation of the day's material and then allow time for individual seatwork, if there's time for that.. Sometimes there's a bit of variation. I'll give some kind of assignment to begin the lesson, or an investigation to begin the lesson, or a quiz to check on how the kids have done from the day before.*

Judith explained that this means she answers students' questions about difficulties they encountered with the previous day's assignment, by offering her solutions. By 'seatwork' Judith means that students begin working on an assignment of practice exercises and problems, usually from the textbook or a worksheet, which is completed for homework. Judith believes that this type of repetitive practice is an essential component of mathematics learning. Although it is most common for students to work individually at their desks, some informal paired or small group work is permitted, as long as the working environment remains peaceful. If there is time after she has taught the lesson, Judith circulates among the students to help and encourage those who are struggling.

Judith collects and marks much of the assigned work to discover the mistakes that students are making. Subsequently, she points out

> *the mistakes they make in the hopes that the students who have a) made the mistakes won't make them again, but b) if they are going to make them, they understand sort of what can be behind making a mistake, in terms of the test or the assignment.*

This process of indicating and correcting errors occurs on individual student's papers, and, when many students have made the same mistakes, the correct thinking and/or processes are demonstrated to the whole class. Marking assignments and homework allows Judith to collect marks, which together with the students' marks from quizzes, test, unit exams, and mid-term and final examinations, culminates in the students' formal assessments.

Both the Pure and Applied Mathematics curricula anticipate that students will learn by constructing their own mathematical knowledge, and encourage students to be activity engaged in the learning process. Activities, investigations and projects of the type exemplified in the authorized textbook resources are one route to achieving this goal. Judith calls these investigations or projects, *experiential* or *experimental* approaches to learning mathematics. Like several of the other teachers in this study, Judith focuses on the Applied Math program when she speaks about this type of teaching and learning.

> *In the department I'm working in right now there's a real conscientious effort to take that experimental type of approach into* [the Applied Math] *classroom. And I think the fact that Alberta Learning has said this is the way we want it*

taught, and they've incorporated that into their curriculum document, and that is the document we work with, ... it definitely has an influence on the way you do things. Now that isn't to say that under other curriculums I didn't try some of the ideas that are currently stated in the new curriculum, because I have tried to incorporate an experiential learning pattern into my other courses, as well, but it is stated now, so it's got to be done.

She is unsure whether the approach she regards as mandated in the curriculum documents is reliable and will enable students to be successful.

You know, taking out the repetitive structure in Math is causing some problems, I think. Students need the practice, they do. And I asked about it in our staff meeting. I said, "Was this an issue for you guys in the 13/23/33 ?" And the answer was, "No", because that was a more traditional approach to math. So, I don't know. This Applied program is causing all sorts of questions, you know. I don't think it's necessarily a bad program. In lots of ways it's very interesting and I like that there's less content in there, and it can be very process oriented, but, I don't think they've got it quite right, for those kids.

In spite of her concerns, and because she understands that the approach is mandated, Judith tries to incorporate investigative work into her Applied Mathematics teaching, and is the *"little bit of constructivism inserted where it can be"*. Judith's approach to activities and investigations is to modify her usual teaching routines. She explains the activity and the expected outcomes, then circulates among her students, offering guidance and support, as they engage in the activity. She has made these efforts in the past, with little success, and continues to have the same poor results. She finds that students in Applied Mathematics classes do

not take the opportunity to explore, or engage in the activities, even though there is class time provided to them. I don't have a lot of kids turning in their projects. Maybe 50 percent of the kids were turning them in.

In the Pure Mathematics classes, she finds the curriculum is very full and there is not enough time to incorporate experiential teaching and learning. Consequently, traditional, transmissive teaching is best suited to this program.

Judith is confident and comfortable with her comparatively traditional, direct teaching style. She is concerned that the 'constructivist' approach to learning may not be a suitable vehicle for student learning, given the type of students ("*non-academic*") served by the Applied Math program and the volume of material to be covered in the Pure Math program. Her experiences as a teacher and a student lead her to comment:

The learning objectives that are incorporated into the curriculum are specific, and the most efficient way to get to some of those objectives is through direct approaches. And so in terms of what is being asked of us to teach, the way to get to that, that goal I guess is through a particular methodology - one we have seen works time and time again, in large classrooms, with lots of kids, with short time periods for learning.

The Middle

When Judith spoke about her understanding of the word middle in the context of 'teaching to the middle' she said

the middle for me right now is just being defined because I've come out of a different context, where teaching is more, the middle there is quite different to the middle here. So I don't have a set definition for middle- at this point.

She assured me that she had developed a clear understanding for the word in her previous teaching situation and I wondered in what ways she felt this meaning was altered in her current teaching situation.

The middle is different in terms of what the kids can do [there], *we were grabbling with issues of missed knowledge, missing language, social issues that come into the classroom, so the learning and the ability to learn was quite different, than what I see in the school right now. ... I'm working with a different group, they learn so much quicker, even the ones who are not academic, their ability to grasp onto the ideas and express those ideas is much quicker, than I was used to. ... Quite often my definition of middle was determined by what the curriculum standard was, and the students have to meet that standard to advance, so I guess I must consider middle from that point of view, too.*

Since Judith implied that her understanding of 'middle' is connected to the abilities of her students and the rate at which they learn, and the standard of the mathematics she teaches, these were the two meanings we pursued in our conversation.

The Students

When Judith plans her teaching, she prepares so that most students in the class will be able to meet the curriculum objectives and the standards. Although she reviews students' marks from previous mathematics classes, she relies heavily on her day-to-day informal assessment of students as they ask questions and respond to her questions to formulate her perception of the abilities and attributes of the middle group. She finds that the middle group varies from class to class

because if you have three sections of Math 10 Pure, they're all going to be different, and how you approach each class has a lot to do with your overall perception of that class. ... Each class is different and has to be treated as such.

Because she prefers to use an interactive style of direct teaching, where students direct some of the teaching with their answers to her questions, Judith's perception of her students' abilities is greatly influenced by those students who speak up. Consequently,

I miss out on the kids who are not going to speak up, although I'm always trying to look for those kids.

I asked Judith if she could tell me about students she would say were in the middle group, for whom she plans her teaching:

Well I'd have to make a distinction between the Pure and the Applied because the middle in both streams is different. ...Within the Pure stream, the middle group is around your class average, say 60 – 70 %. Those are the kids, that, they catch onto ideas fairly quickly, but maybe not completely. And, I guess, their priorities are not always wrapped up in school. So they do what they need to do, to get the curricular content under control, and then they leave it. They don't stick with it to bring it up a notch. ...They maybe have some questions in terms of the curricular content, but there's not too many serious

errors. They've basically learned how to play the school game, and the math game. And they're good at procedural knowledge and they can take that knowledge and make it work for them. ... They expect to be told. And their job is, they sit and listen and process the information and they spit it back out. And they see that as their role in school

When Judith spoke about the students who are in the middle group of her Applied Mathematics class, she distinguished a middle group in terms of achievement:

Right now their top marks are 60s and 70s. Last semester we didn't have any students achieving over 80, so our middle stream is 50, I guess. Yeah, a lot of kids are sitting at 40s and 50s. The middle group are kids who are working at the 50 to 60 range;

and in terms of attitude and aptitude:

their efforts are somewhat consistent in class, they tend to attend quite frequently, they're usually there. They – often won't do the project, so that brings their marks down. - - Assignments that are given to help them prepare for tests are – sometimes done, sometimes not. Sometimes they are test writers; sometimes they're not.

She found it difficult to generalize about the middle students in her Applied Mathematics class. Most often she referred to the wide range of attributes and characteristics of these students, rather then the middle group.

I find in the Applied there's more of a range of students in terms of personalities and what's important to them, and how much work they're willing to do and what they understand and what they don't understand. It's very much a mixed bag in there, that Applied group.... So this is a group that really struggles with math. So the kind of student who is being attracted into the course, they're not really strong coming out of grade nine and - - yeah it's very hard for them to achieve in a way that's going to be excellent.

Mathematics and Standards

Judith also interprets 'middle' in relation to the mathematics she teaches. She believes there is little opportunity to deviate from the Alberta curriculum:

A curriculum in Alberta is legally mandated. And so you are obligated as a professional to present the learning objectives that are set out by Alberta Learning. … So the curriculum has a huge influence on what you teach.

The challenge for Judith is in covering the mathematics in the curriculum in the time available. Her emphasis is on striving for and meeting the curricula objectives.

Also influential are the provincial standards, which are used to judge students, teachers and schools. Judith ensures that she provides examples, practice exercises, assignments and assessments, which include work at the acceptable and excellence levels, as suggested by Alberta Learning. She explains and demonstrates examples of questions at the standard of excellence to students in both the Pure and Applied Mathematics classes.

When selecting questions for a Pure Mathematics assignment, Judith selects questions from the A, B and C sections in the textbook, emphasizing the A and B questions, those of easy and medium difficulty. This is a technique that Judith has always employed and it has not changed with the new curricula. Judith's question

selection is similar in Applied Mathematics, although the textbook for Applied Mathematics

> *does not have the same demarcation level. I think it's still there because the questions do tend to get progressively harder. But the practice section is much smaller and I find the kids run through these, sometimes, because they have extra time at the end of class, because they're finished.*

In addition to answering questions from the textbook, Applied Mathematics students engage in projects and investigations. These are outlined in the textbook and the curriculum documents. Judith, along with other teachers in her school, modifies these activities, bringing them down to a level that is suitable for the students in the Applied Mathematics program.

> *The projects that are in the Applied program right now are not aimed at the middle, they are aimed at the upper end kids, who is an academic kid. ... What we are finding is that we have to restructure those activities so that they're more clear to the middle student, to the lower end student.*

Teaching to the Middle

When Judith completed my initial survey she indicated that some times she taught to the middle, but other times she did not. When she is teaching to the middle she is

> *trying to meet as many needs in the classroom as you can, which would mean* [my teaching] *would be generally directed at the middle learner. The low-end learner won't get what they need from you and high-end learners won't get what they need from you. ... Most students would seem to 'get it' - exams results indicate this, as does work in class. ... Bright students are bored, but slower students struggle.*

Judith reflected upon a time when she was teaching an Honours Pure Mathematics class, in which the majority of students were able to grasp concepts quickly.

> *Then I realized that there was a minority in there that just couldn't follow. But I couldn't, I guess I didn't feel that I was going to make a decision to hang up all of that good discussion for four kids. May be that's not fair, but that's the way I approach it.*

For each of her classes, Judith plans and directs her teaching towards the majority of the students. This means adapting what she teaches and assigns so that most students in the class will be able to understand and complete the assignment. She does this by determining what level most students in her class can work at and planning her teaching at that level. Judith says you have to develop a feeling for what is going on in the classroom and respond to your perception of the needs of the largest group.

> *When I think about teaching to the middle I think about the majority, trying to get the majority of the kids through the curriculum.*

Not Teaching to the Middle

When Judith completed my initial survey, she indicated that

> *not teaching to the middle would mean that you teach the curriculum objectives without modifying except to clarify some obvious points or gaps.*

When I asked her to tell me about not teaching to the middle, she replied "*it would depend which end I'm looking at.*" First, she spoke about teaching Pure Mathematics to a high achieving class.

> *My lesson are far less explicit. The number of things I explain, in terms of procedures increased. So I might do a manipulation of a formula, without explaining how I did it – coming up with the isolation of the variable. And in doing that kind of thing, my teaching style changes, so I don't give the explanation. You know I'd say, "This is the way you do it, and now go and do it and explain why you've done it. The students would have to come up with the explanation on their own. Those kids could make leaps and so I let them make leaps. ... I was aware that they could do this and so I just totally built off those kids. ... They were contributing to the lecturing and the formation of notes on the board.... ... We did it together. .... There really wasn't a middle, the middle was totally upper end.*

In this situation Judith did not have to look for ways to modify the concepts and explanations for students who were struggling, but could rely on the curriculum objectives and standards to guide her teaching.

Judith also says she is not 'teaching to the middle' when she is teaching classes of very low achieving students. In her Law 19 class, she has students with a wide range of low-level abilities. Judith is accustomed to teaching relatively homogeneous groups of students who have been selected for their programs, and finds that the relative range of abilities is greater in this class than in her Pure and Applied Mathematics classes. Teaching the whole class together is becoming impossible because she cannot find a level at which to teach. Judith has decided

> *to split them into two groups, so that the ones who are slower, and it really is a function of being slower, can work at a slower rate.*

With these students Judith will use her customary direct teaching approach and teach so that the majority of each group can be successful.

> *OK, if I'm looking at the lower end, I'm very much pointing out the obvious. ... So, if I go down and try to teach the lower end, it's extremely explicit. I'll say, "It is this way because of this" and you can't help but bump into the answer.*

While this is her description of teaching a very low achieving group of students, she explained that she is often this explicit with her Applied Mathematics classes and Pure Mathematics classes. Judith's initial comments about not 'teaching to the middle' apply when she teaches classes of top-end students who all appear to be motivated and learning at the same rate. For classes of low achievers, it is clear that she modifies and adapts the curriculum, and is still in effect 'teaching to the middle'.

Throughout our conversation, Judith's stories were peppered with the frustrations she is currently experiencing in teaching. These frustrations together with situational influences impact her teaching abilities and the decisions she makes. She suggested that the new Mathematics programs impact students and teachers negatively

> *I don't know if we've got the right thing for the right kids. ... the numbers demand that you have more than 20% in two streams and ... if that's all that gets into those two streams, -- the other 80% would end up in Math 14, and*

that just not acceptable for society. ... And with the uncertainty around the post secondary acceptance of the Applied, most kids want to go into the Pure, so they have some option of doing what they want when they finish.

The pressures to meet objective standards imposed upon subjective activities of teaching and learning, and the volume of students she interacts with daily impact her efficacy as a teacher. She teaches or coaches over one hundred students a day and often feels overwhelmed.

I think that as an educator, the difficulty with our system is that there are some kids you just know you're never going to meet the need of. Be they high end or low end, kids, and that means inevitably you feel frustrated. With higher end kids, they can sometimes meet their own needs, because they find ways to explore things in a way that is meaningful to them. But your lower end kids, who are sitting there, and they have no idea, you can't spend an hour with them to help them get the idea. It's very frustrating ... because there's a real affect there. .... It's very hard because you can't forget the humanistic side to what we do. And if you're an educator who cares, you're going to be hurt by watching what these kids go through. So, I guess that would be a closing thought for me. I find it hard to watch kids who don't get it.

Judith's interpretation of not teaching to the middle is related to teaching classes of students whom she perceives as being more homogeneous than usual; classes which seem to have no to-end or low-end students. In these circumstances, Judith considers that her teaching encompasses all the students in her class. In the next chapter, David reveals that his interpretation of 'teaching to the middle' attempts to encompass all of his students, but in ways that are very different from Judith's, or any of the previous teachers'.

CHAPTER IX

David's Story

Background

David has been a teacher for eleven years. He taught in an elementary school for three years and has been teaching in an urban junior high school for the last eight years. His background is in Special Education; he minored in mathematics and does not consider himself to be a specialist mathematics teacher. This year he teaches mathematics to two grade seven, eight and nine classes.

Teaching to the Middle

When David and I began to speak about 'teaching to the middle' it was obvious that he was very comfortable with his interpretation of this phrase. However, almost immediately, he inquired whether I was finding that the phrase had negative connotations. Suspecting this to be the case, he said he prefers to say that he 'throws a blanket' over his students.

> What I do is I take a look [at the class] and I toss my blanket over top of that group and the blanket will cover the majority of the students. Like, there will always be those students who fall outside the blanket. And what you do then is ensure that those kids, who are outside the blanket, are covered by the blanket in some way. ... And I'll use a variety of methods to try and meet the needs of that student. So that to me is the way I sort of interpret 'teaching to the middle'.

David's 'blanket tossing' has its basis in his Special Education background and individualized teaching.

> *Individualized teaching, individualized programming is great, philosophically. As a Special Ed. teacher I could do that every single year. If I could do that now, everything would be wonderful, but how is that feasible in the class of 28 to 30 kids we have today, and with all the other issues that encompass us as teachers?*

David perceives each of his students as unique individuals; he is frustrated because he feels unable to teach them as such. He justifies his 'blanket tossing' or 'teaching to the middle':

> *I am using this approach because I haven't been taught any different. OK, I've got my Special Education background, where I can individualize programs, but not for 30 kids. You know I'll modify as much as possible, but when you have 30 kids, the reality is I don't have the skills, and in school I haven't been taught the skills to design a program for 30 different levels. You know, in the end, it's for the group. The program isn't modified individually.*

During the course of our conversation I attempted to discover David's meaning for his phrase, 'tossing a blanket over the group' and its association with 'teaching to the middle'.

David's Teaching Style

Over his eleven years of teaching David's teaching style has evolved and continues to do so. When he began teaching in an elementary school, he found that his students were *easily frustrated if they were not shown exactly what to do*, and he utilized a *step-by-step* teaching approach, explaining and demonstrating procedures. When he moved into teaching at the junior high school level, he found that the students were *more mature, had greater experience and confidence and ... could deal with the frustration a little more*. Consequently, he began to modify his teaching approach. At the same time, David's growing understanding of his students' characteristics and his experiences as a teacher, together with his belief that children learn differently and require different learning opportunities, prompted him to modify his teaching so that he now uses a variety of approaches in the classroom.

Underpinning David's teaching is his strongly held belief that students are all different and should be taught in a manner that is appropriate for them. He associates this belief with his understanding of 'learning styles'. His training and teaching experiences have led him to recognize three dominant learning styles in his students: visual, auditory and tactile.

> *I'm really a big believer in testing what kind of learning styles, visual, tactile, auditory, first week of school I test all my students, and I try to teach them what kind of learning style they have. Okay, that's one of the most important things a kid can remember, is what kind of learning strategy they have.*

David consistently finds that '*70 – 80% of the kids are strongest in visual/tactile*. Consequently, when he plans his teaching he focuses primarily on a visual/tactile approach. To appeal to the tactile learner, David uses concrete materials such as Alge-tiles, cubes, rulers and bingo chips.

> *A lesson tomorrow is on perimeter. The first four questions they have to do tactile-y. They have to pick up the ruler and actually measure. It's a task, not from the textbook.*

Students can use manipulatives whenever, and for as long as, they want to, and they can be used during tests. David bases the sequencing of his lessons upon the textbook, but he modifies the presentations and explanations offered by the textbook because he finds that they are difficult for visual learners to follow.

> *In the grade nine algebra unit, the problem-solving, the equations, the algebra, I change it around so it becomes more visual, easier to read, because I find ... if you're going from one side of the page to the other, and six sets of brackets, kids have difficulty, I find in math, going from left to right, straight across. Whereas up and down, in columns is way more visually understandable for kids, and they can se the organization better, so I use that a lot.*

Auditory learners benefit from David's spoken explanations and from communicating with other students when they work in small groups.

In addition to planning for different learning styles, David also *uses a variety of methods to try to meet the needs of the students*. He used several phrases to describe the teaching strategies he uses: *traditional teaching* or *chalk and talk*; *guided discovery,* and *backwards chain rule*. He explained that he uses 'chalk and talk' when

he wants to show the whole class a method, an idea or a concept, at the chalkboard. When he is teaching directly to small groups of students, he uses the phrase 'traditional teaching'. He described his meaning for these phrases:

> *What I think is a traditional method, ... is, OK, here's a concept, and here's the rules to apply to this type of question.* [My] *traditional method is, "So, we know how to multiply. ... This is how we multiply. Now, this is 2x and this is 3, Okay? We need to multiply them. How can we build the answer?*

David then goes onto gather information from his students, as he uses concrete materials at the front of the room, which will demonstrate and build a method and an answer. The teaching he describes is teacher-focused, but full of meaning, rather than abstract. David finds that students, who struggle to learn mathematics, the lower ability students, learn best with this style of teaching.

> *You eventually get to* [the answers] *step by step, using a traditional approach, and you bring those guys in. That's the way they seem to learn.*

A second approach used by David is 'guided discovery'. There are many interpretations of the phrase 'guided discovery'; David explained his understanding of this teaching approach.

> *You give students a task and let them work on it independently, and then you review it with them. An example. Let's go back to Alge-tiles. The students have some pre-knowledge, Okay, about adding. And they've got some pre-knowledge about using the tiles. So, you ask them to demonstrate how you can model multiplying. With guided discovery, you get them to come up with the answer instead of you giving it to them.*

This is the approach David finds he uses most often because the majority of his students can engage in the guided discovery activities that he presents.

A third teaching approach identified by David is 'backwards chain rule', an approach he finds successful with the upper end students, who tend to dominate the classroom discourse, unless they are involved in a more challenging activity.

> *The same concept* [2X times 3] *with a totally different group, at a much higher level – you maybe do the 'backwards chain rule'. Here's a situation and here's my answer. Now you tell me what the question is. Much higher thinking levels, you know, analyzing, synthesizing.*

There are times when David uses a single teaching strategy, the 'backwards chain rule' for example, with the whole class. Then, the top-end students work on the question, while he provides an increasing number of hints to the other students in the class, so that they can also engage in the task. David says that even the lower-end students eventually find the answer as a result of a series of incremental hints that take them through a step-by-step process.

Although David is mindful of the different learners in his classes and the various teaching strategies he can employ, his teaching experiences have led him to believe that most students learn certain concepts in particular ways.

> [I have] *an idea of what has worked in the past for students, and what strategy or method has been most successful for most students. A lot of it is from previous experience working with kids, in terms of how they have interpreted specific concepts, whether it's a visual or a tactile model that has worked in the past. And I use that previous experience more than anything.*

Ultimately, he relies upon

> *different learning styles, what the concept is I'm teaching and my experience to determine what style of learning and what teaching strategy I'll use for that particular lesson, with that particular group of students.*

David never forgets that he is teaching a class of individuals and continually tries to understand how each students learns. He confirms his assessment of individuals' learning styles by talking to students about their work.

> *Well, I always look back to the kids. And when I go and I say, "What were you doing here?" You get to see what they are thinking. That way you get to know the kid and the way they think and their learning style, and what works for them and what doesn't.*

David examines students' written work, trying to understand the thought processes that culminated in the solution offered.

> *And then I say, "I bet she was thinking like this", and you make sure you are on the same wavelength. And you, you know she's that type of learner and she needs a pat on the back, and then you can go back and make sure you are accounting for it.*

As might be expected, it was difficult for David to describe a typical lesson, since he says he changes his approach from day to day and class to class.

> *More often than not I try something, then I try something different for the next class. I've never done it the same way every time.*

The one invariable in David's classroom is the opening puzzle he uses each day.

> *One thing I do is start with a puzzle. In the puzzle I'm getting a lot of kids to class on time. Because I try to get the puzzle right on the board, so if the kids are on time, and there's a puzzle, well the first thing I have to do is I have to have a pen in my hand; I have to open my book, and I have to start working on the puzzle. So it sort of takes up the first three or four minutes, for kids who get here late. ... It gets the pressure off the kids and sort of gets them calmed down. And that's more a routine than anything. So then they just want you to go over the problem. The kids just want to know the right answer. They want to know if they get their prize. A lot of people say, "Well it's always the same kids who answer the puzzle", but it's a puzzle, not necessarily a math puzzle. And those kids who don't usually have success, you just get them going and give them hints and so the next time: Boom! They're right!*

David uses the puzzle as a classroom control tool, but it also demonstrates an essential characteristic of his teaching: the need to address the social and emotional needs of students, in addition to their academic needs.

> *I believe all kids are capable. That may be a bit high, but if I can get them believing in themselves ... then they might have some success. It's a bigger issue than the number or the type of questions they do. ... It's not just about math concepts; it's about social and emotional issues.*

He reflected upon the integration of special needs students that has occurred in Alberta in recent years. His educational background and teaching experience in Education provide him with a unique insight into the issues.

> [The students'] *problems haven't gone away, they're just mainstreamed now and it's up to the teacher to adapt. ... and with those students comes social*

and emotional issues. Maybe in the past they were top of their class and now ... well it's an issue all by itself.

And about reasons for students' poor performance in mathematics:

It's disappointing you know. There's certainly more than one reason for them not understanding a concept. They did poorly, but there's broader issues than achievement or effort.

David explained that teaching mathematics is about more than the mathematics: it is about making *kids feel good about math*, increasing self-knowledge, and raising *self-esteem*. He regrets that these are no longer priorities for many educators.

When I first started teaching, one of the priority goals was "feel good". And we all had those feel good days and every one was supposed to be trained in a self- esteem program ... And the philosophy was if they feel good about themselves they'll achieve academically. Now it's if they achieve academically, they'll feel good about themselves.

The Middle

The Students

(Those who are under the blanket)

David initially plans his teaching to address the needs of the majority of students in the class, those he says are "under the blanket". Each year he explains this phrase to parents during the parent-teacher interviews.

I describe that I have an eclectic group and I explain what I do is I take a look and I toss my blanket over top of the class and the blanket will cover the majority of the students. Like, there will always be those students who fall outside the blanket. And you need to ensure that those kids, who are outside the blanket, are covered by the blanket in some way.

This explanation is an effective analogy, but I wondered what David meant when he said he 'tossed the blanket over top of the class', and how he determined which student were covered by the blanket and which were not.

At the beginning of the school year, David tests his students to discover their learning styles. Since 60 –70% are tactile learners, this is the first indicator that a student will fall 'under the blanket'. Also, at the beginning of the school year he looks at the students' marks from their previous mathematics classes, but he treats these with suspicion because

I have found some students who have had 60s and 70s in the past, which is a reasonable measure of achievement, but for some reason they don't fall under the blanket with that particular group.

As the school year gets under way, these initial assessments are modified by David's day-to-day observation and assessment of his students. He finds that students' individual growth and achievement in his classes are a better indicator of who is 'under the blanket' than marks from previous classes.

How they perform, in class and on tests, is an indication of whether or not they are successful and whether they fall under the blanket or not.

David finds that 'under the blanket' students can work independently on questions from the textbook and can begin work on a guided discovery task without first asking questions.

If they can sit down and actually read the questions and try to work it out for themselves before instruction is given and before, you know, examples are given.... That is my first real key skill for them, for them to be considered part of that group [under the blanket], is for them to be able to do that and then to show me some independence, so now I can actually do a new questions and try to work it out on my own. At least try before asking for help.

These students are usually not behind in mathematics, nor are they in need a challenge, and they can usually work well in small groups or in pairs. However, as we spoke about the characteristics of students who fall under the blanket, David cautioned

it's also a day-to-day process, you have to read the signs along the way. Who's under the blanket can change from day-to-day and concept-to-concept. ... Who gets under the blanket? It's not just a mark, it certainly not just a mark on a report card. ... I don't think there's any set rules for anyone.

Students' Who are Not in the Middle

(Those outside the blanket)

The students who are not under David's teaching blanket are *most often those who are behind in math or who need that challenge*. In the heterogeneous, integrated mathematics classes in David's junior high school, he sees a wide variation in student ability and achievement.

Take my new grade sevens and oh my gosh, I've got students who could go into the grade eight program and excel at it, and in the same classroom I've got students who are functioning at the grade two level. So that's the range.

The lower end students include children who have previously been in modified programs or special needs programming and find themselves in the general school population, as well as student who are behind their peers in mathematics. They also include students who have had 'bad experiences' with math in the previous six years. David encourages students who have previously had difficulty in math to *change the way they do things and try something new*. If they do not make the changes, David often finds that they are 'outside the blanket'. Characteristically, within the first few moments of a task, these students will ask

"What do I do in this question? What do I do here?" .... They won't even read the question for themselves. And they're so used to, "You do this and you do this and you do this" that they can't seem to work any other way. .. They don't seem to have the ability levels to think at the higher thinking levels. ... They work slowly and become easily frustrated.

David uses his skills as a teacher to find different approaches to bring these students under the blanket, but he laments that

as hard as I work to try to get to them, there's always someone who doesn't get it. And so there's always some of them outside the blanket.

David also finds that there are students who excel in mathematics in his classes; these students also 'fall outside his blanket'. They tend to talk a lot and dominate the classroom proceedings; they become excited and will often shout out answers if given the opportunity. However, these are

keen learners who are interested in participating in those upper level math contest - the Pascal and Gauss math contest - .

They love a challenge and are self-motivated. David is able to provide learning opportunities for them within the classroom that maintains their enthusiasm for mathematics.

The Mathematics

During our conversation, I asked David whether all the students worked on the same mathematics or if he differentiated in this area, as he does with his teaching strategies. He replied that he is responsible for teaching the Alberta Mathematics Curriculum, so *everybody does everything. The content is the content.* However, he modified this remark.

> *As I've said, my approach to that content is ... will vary. And I'll say, "we're going to do Alge-tiles and discovery" and some kids, it's just 'wow' over their heads, and then you break it down for them. But they all have to do all the same content. Some kids, yes, get fewer questions, but they are the same questions, but they just don't do as many repetitions....because it takes them twice as long to do them and that just adds to their frustration. And the kids at the higher level, have not more questions, but have one more question, and it's at a much higher level.*

The 'content' David teaches is a reflection of the mathematics in the textbook and the Alberta curriculum. David tends to follow the sequencing of the textbook *chapter by chapter*, because he thinks that the textbook authors are experts in this field, and brings more skills to this task. However, David does things *differently from the text because I do things differently each year ... sometimes with each class.* Consequently, the questions David chooses for students to work on may come from the textbook or from other resources. When he selects questions from the textbook, he chooses the questions to assign after consideration of the group of students he is teaching.

> *Sometimes I say, "Do all the evens". Sometimes I'll say, "Do all the odds". Sometimes it would be a waste of time because they're well above the first twenty questions. I'll say, "Do 20 –40". Sometimes I'll say, "OK, do this one this one, skip that one do this one, skip these, because we're going to be going into it more, and the do these". It's never one way or another, it varies.*

David finds that the provincial achievement tests influence his decisions about selecting mathematics content for his classes. He knows that, after three years in junior high school, his students will write the mathematics test when they are in grade nine, and they must be prepared for this event.

> *There is no choice about that influence because it's from the top down. We are, in my opinion, dictated by the tests. We have to go away from our own testing, to make tests, which are similar to the provincial tests. We are selecting what we are saying and using examples to be exactly the same as the tests, or we are doing more testing, on out students. And our goal is success on the Alberta Achievement Tests. Period.*

Although David is not very positive about the provincial achievement test in mathematics, he is careful to expose his students to tasks and questions of the acceptable standard and the standard of excellence.

David's Conclusion

David continues to look for ways to improve his teaching; he attends conferences and reads journals, and he reflects upon his success and failures.

> *You know when a class gets 76% on a unit exam, and I still think, "That's not right". Sometimes I wonder whether I would have been happy if the average were 90% - maybe not. I don't know, 76% on a unit exam that's pretty good, but man it's hard, these three kids who've only got 60 or 50. They should've been able to get better, you know. Well, I always look back to the kid and try to understand where she went wrong and see if I can do something different, to help her.*

He says:

> *You do things from your experience and you do things the way you've been taught to do them. And I do what works for me and I get results.*
> *If there's something else out there, I sure hope they get it spread around. ... But let's not say, "Hey this is what you should be doing and this is the way to do it", without telling us how it is feasible.. Why can't we just take the middle ground and say there's no one way that's perfect?*

David's stories have presented yet another interpretation of 'teaching to the middle'. These stories have revealed differences of meanings as well as similarities to the stories told by the previous five teachers. In the following chapter, I will briefly review my research method and then enter a discussion of my interpretation of these teachers' stories, and the implications of 'teaching to the middle'.

CHAPTER X

Discussion

My goal in undertaking this study was to discover what teachers mean when they say that they 'teach to the middle'. From my initial conscious awareness of the phrase, through the planning and enactment of my research, I have endeavoured to come to an understanding of this teaching slogan or phenomenon, by listening to and interpreting the words of the teachers who participated in this study. Initially, I collected data using a survey, then followed this with a questionnaire and later an interview with each teacher. Each of the teacher's stories in the preceding chapters represents an individual teacher's description of 'teaching to the middle'. Read along side each other, they paint a picture, an impression, of 'teaching to the middle'. The stories, and my interpretation of them in the following pages are not intended to be read as generalizations to all cases of 'teaching to the middle', but reveal a aggregate impression that exposes some of the layers of understanding and interpretation that teachers, who use the phrase, and I now, have for it.

The initial survey responses indicated that 'teaching to the middle' was a phrase that resonates with many teachers whether they claim to teach this way or not. These teachers were able to articulate a meaning for the phrase, which indicated to me that they had seen or experienced a phenomenon that they recognized as 'teaching to the middle', either as students or as teachers. The phrase represented a focal point for 'connection-making' and associations in the minds of those who heard or read it. Although necessarily rather wide-ranging, there were many similarities within the meanings expressed, suggesting that there might exist a general, if not 'taken-as-shared' understanding for the phrase. One area of divergence related to whether those who claimed to 'teach to the middle' would provide modified learning opportunities for students who were outside the middle. Some survey respondents indicated that they thought teachers who 'teach to the middle' would make these accommodations, others thought they would not. Although many of the teachers who responded to the survey did not claim the practice as their own, nor did they wish to participate in a deeper discussion with me, their comments provided a starting point from which to investigate the teaching phenomenon as it is lived by mathematics teachers.

During my conversations with the teacher participants, who did agree to participate, it became clear that certain aspects of 'teaching to the middle' could be spoken of in isolation: how the teachers described their teaching, or their understanding of the middle they said they were addressing when teaching this way. The meanings were further revealed when, although I did not ask why they taught this way, the teachers offered their reasons, directly and indirectly. These reasons formed an integral part of their, and my, understanding of this teaching phenomenon or slogan. In this chapter, I discuss the ways I have come to understand 'teaching to the middle'. First I examine the meaning that the teachers have for the phrase, and answer the first three of my supporting research questions. Then, by considering the characteristics of teachers who say they 'teach to the middle', and their reasons for doing so, I reveal further layers of understanding for the phrase and those who claim to enact it.

How Teaching is Described

This discussion of the teachers' descriptions of their teaching is predicated upon the assumption that teachers are able to articulate clearly and accurately what they do in classrooms. When the high school teachers described their teaching, their first thoughts and comments were about their teaching in Pure Mathematics classes, although, with the exception of Diane, they have all taught Applied Mathematics classes. This indicated to me that they had the greatest degree of comfort in these classes, using their described teaching approach.

Teaching Metaphors

An examination of the teaching described by the high school teachers reveals that most instructional time is centred on teachers' explanations and demonstrations of procedures followed by students working on practice exercises and assignments, as they try to master the processes outlined by the teacher. Steve's comment, that he has the knowledge and it is his job to pass it along to his students, was echoed in the descriptions offered by the other high school teachers. They find the most effective way to pass this knowledge along is to "*break the concepts down*" into steps that can later be "*reassembled*" using the procedure or blueprint offered by the teacher. It is necessary to "*translate*" the mathematics "*into an understandable form*" so that it becomes more accessible to students. Instruction is "*aimed and targeted at*" the students. The textbook is central to the teachers' planning and enactment of lessons. It is expected that if students work hard enough they will learn enough of the mathematics that has been presented to be successful: "*I expect the students will take as much as I can offer and do with it the best that they can*".

There are variations in the descriptions of teaching revealing many metaphors: the classroom as a workplace; the teacher as manager; the teacher as mediator; the teachers as assessor; students as vessels, and so on. Diane's description of her teaching reveals her dedication to the workplace and telling metaphors, in which students will be successful if they work hard enough, complete assignments and learn what she teaches. In her description there is distance between her and her students. Diane is comfortable and confident in her teaching approach and is not inclined to modify it, even to meet curricula expectations. Martha, whose teaching follows a similar pattern, claims that she would like "*to teach differently*" (to use a constructivist approach) but she has met resistance at all levels whenever she has attempted to enact alternative teaching practices. For Martha, it is important for students to be compliant, not restless or resistant. In her final years of teaching, she has conceded that a traditional teaching approach, which incorporates the use of technology and manipulatives, in line with the letter if not the spirit of the curriculum, causes the least perturbation. Steve's teaching is also predominantly transmissive. He explains concepts, and demonstrates procedures and the use of manipulatives to students. He checks for student understanding by having each student orally answer a question from the textbook, before allowing the class to begin on the assignment. Steve justifies his approach with measures of his success: he is a popular teacher, his student attendance rate is high, and students achieve good examination results.

Judith was the only teacher to describe an interactive style of teaching in which students' thinking guided and directed her explanations and demonstrations.

She is the medium through which students' ideas are channeled and sieved. She prepares a flexible plan for her presentation, asks questions and encourages student discussion through her, then allows their lines of thinking to direct what happens at the board. Judith's teaching is modeled on the teaching she received as a student and has evolved with her teaching experiences, to this point. Sara, the youngest teacher, characterizes her teaching using mixed metaphors. She is the social director, who wants "*to make math class fun*", and have a close, rather than distant, relationship with her students. She also sees herself as a *"a mother hen"* or an older sister, who can chide or charm students into learning. She is experimenting with experiential learning in Pure and Applied Mathematics classes, but her emphasis is still with the tried and true transmissive approaches she experienced as a student.

David, the only teacher in this study who is working at the junior high school level, described his teaching quite differently from the high school teachers. The way in which students learn and his understanding of their learning are the focus of his teaching. His education and experiences as a special education teacher have equipped him with the skills to test his students learning styles. Based upon the results of these tests, and his observations of students, he plans for and enacts a variety of teaching strategies that encompass audio, visual and tactile learning styles, in an effort to ensure that all his students will have opportunities to learn in ways that are apposite. His preference for teaching strategies such as guided discovery and "*backwards chain rule*" (a strategy that requires students create a situation which could results in the answer he has given) encourage student independence and thinking, and develop students' confidence in their ability to engage with mathematics. Students work together, utilizing concrete materials to facilitate their learning, and all students are encouraged to believe in themselves and their ability to engage in mathematics. David listens to students' explanations and tries to understand each student's thinking, so that he can make teaching plans that promote each one's learning.

An examination of the teaching descriptions reveals that the high school teachers are firmly anchored in the conduit metaphor (Reddy, 1979), which is supported by a variety of other metaphors. The conduit metaphor resonates with Gregg's (1995) school mathematics tradition, and as such teachers are perpetuating the conduit metaphor, when they 'teach to the middle'. David's described teaching more closely resembles the toolmaker metaphor (Reddy, 1979) for teaching, wherein ideas move back and forth between teacher and students. David is effectively in the middle, learning from his students about the ways in which they learn and think, and using this information to create a multi-facetted learning environment.

The Teaching Continuum

Several writers have categorized teaching approaches as dichotomies: algorithmic/procedural - conceptual; imposition – negotiation; traditional - innovative or non-traditional (Anderson, 1998; Cobb, 1988; Thompson, Philip, Thompson & Boyd, 1994). Raymond (1997) provides five classifications for mathematics teaching practices that she characterizes as a continuum along which mathematics teaching practices can be positioned: traditional, primarily traditional, evenly mixed between traditional and non traditional, primarily non-traditional, and non-traditional. My conversations with teachers in this study reveal that each has a personal interpretation

of teaching which would place him/her at a different point along a teaching practices continuum. However, I consider it reasonable to typify the teaching styles described by the five high school teachers as being positioned at the traditional/primarily traditional end of this continuum; characterized by, in varying degrees, transmission and imposition: the dominance of teacher's voice, a one-size fits all approach, the expectation that the teaching and learning will be pre-'pared' and predetermined by the teacher, and that lessons and learning will proceed in an constrained and orderly manner. The force steering the learning is the teacher's sense-making, and the locus of learning orbits the teacher. David's description of fluid, adaptive teaching in which he is in the middle, learning from his students about the ways in which they learn, and modifying and adapting his teaching accordingly, contrasts strikingly with the other teachers' descriptions. In terms of the 'teaching continuum', I believe David may be placed in the region of mixed traditional and non-traditional teaching: he choreographs and controls the learning process based upon his knowledge of his students' needs and abilities: the sphere of influence of his teaching is centred upon and radiates from his students.

In the remainder of this discussion, when I refer to Diane, Martha, Steve, Judith and Sara, collectively, I shall refer to them as 'the high school teachers'. Although I do not want to promote the notion that 'teaching to the middle' is understood differently by the teachers working at different levels of schooling, *per se*, 'the high school teachers' functions as a descriptive, identifying, collective label, in this study. Nevertheless, it is tempting to explain the differences between the teaching styles described by the high school teachers and David in terms of the level of schooling in which they work. However, both Steve and Sara described their teaching experiences at the junior high school level, as being similar to, or even more traditional and direct, than their high school teaching. The disparity is better explained by differences in personal practical theories of teaching and learning (influenced by consciously or unconsciously held beliefs), and by the teachers' focus when they plan and enact their teaching.

A Difference in Focus

A common perception among those who responded to my initial survey was that teachers who 'teach to the middle' use a single teaching approach within their classes, regardless of the abilities and aptitudes of the students. With the exception of David, this was borne out by the stories I heard. The single approach described by the high school teachers, which emphasizes the transfer of knowledge from the teacher to the students, assumes that most students are able to learn mathematics the way that it is being taught, effectively privileges those students who are able to learn in this way, and is divisive. The high school teachers acknowledge that they "*interpret the curriculum and present concepts so that <u>most</u>* [my emphasis] *students can understand them and be successful*". They know that "*bright students are bored*" while "*slow students struggle*" and are left behind. However, none of these teachers provided any differentiated learning opportunities for brighter students (other than expecting them '*to challenge themselves*', or answer the harder questions on the assignments), and failure to do so was lamented but not the focus of any extra effort on the part of the teacher. "*Unfortunately, the four or five* [students] *who are up a level, they get it right*

away, and we don't provide them with any extras". Students who fail to grasp the concepts and procedures as they are taught may be offered extra help (more teaching of the same type) during the lesson, if time permits, or outside of the regular class hours. The teachers' expend their energy in trying to bring these students up to the middle standard. In these classrooms, the focus is on the teaching.

In contrast, David focuses on his students and the diverse ways in which they learn. He begins with his assessment of student's learning styles, then blends in his "*ideas of what has worked in the past* [and] *what strategies or methods have been most successful for most students"* for particular aspects of the curriculum. Beyond this, he is alert to the learning needs of specific students (he questions them to understanding their thinking and the way they learn). By responding to his students and adapting his teaching plans accordingly, he ensures that all students are pulled into the learning community. Beyond this, one of David's major goals is to make his students aware of their learning style, so that they can use this knowledge to their advantage, not just in school but throughout their lives. In this understanding of 'teaching to the middle', the focus is on learning.

It is in this disparity of focus, between teaching and learning that we begin to see two divergent understandings developing for the phrase 'teach to the middle'; understandings that were hinted at in the survey responses. In both scenarios, the teachers see their students in groups, and plan their teaching to meet their perception or interpretation of the needs of the group. In one meaning, teachers use a 'one-size fits all' approach to teaching. The teachers try to control and constrain students' learning, and plan their teaching to target one large group of students, whom they believe are able to learn mathematics the way they teach it. They are aware that their teaching will not blanket some students; some will be positioned, like statistical outliers, outside the locus of learning. Judith's comment, *"maybe that's not fair but that's the way I approach it"* adequately reflects the high school teachers' feelings. This outlook has no place in the second meaning. The teacher begins with what he knows about his students' learning (*"most are audio/visual learners"*), plans his teaching to encompass these students, and then uses alternative teaching strategies and learning opportunities to bring the rest of his students into the learning community. All six teachers claim to 'teach to the middle', yet there are significant differences in the descriptions and focus of their teaching, which indicate that there is more than one meaning for the phrase 'teaching to the middle'.

How Do Teachers Understand 'Middle' in Reference to 'Teaching to the Middle'?

All of the teachers used the word 'middle' to refer to the major group of students in any of their classes. The word was used synonymously with 'majority', 'most' and 'bulk'. Middle was also used to refer to the level or standard of mathematics that is taught. A third meaning, was a programmatic meaning, related to the hierarchy of high school mathematics courses offered in Alberta's high schools.

A Middle Program

All of the teachers spoke about the hierarchical nature of the high school, and to a lesser degree the junior high school, mathematics programs. Depending upon the availability of programs within schools, the students with higher marks are filtered

into Advanced Placement (AP) or International Baccalaureate (IB) programs, or 'excellence' versions of Pure Mathematics or junior high mathematics. In some regions, particularly in some rural or inner city schools, none of these is available. For all the teachers, the Applied Mathematics program was ranked below the Pure, AP and IB mathematics programs, but above Math 14/24 and IOP Math.

Teachers spoke about the courses and the students they teach in relation to this hierarchy. Consequently, for example, when Diane, whose school offers the Advanced Placement program for high achieving mathematics students, spoke about 'teaching the middle' she was referring to teaching the Pure Mathematics program in her school. Similarly, when Steve first began teaching mathematics at the high school level, he did not expect to call teaching the Pure Mathematics program, 'teaching to the middle'; he felt this would be a program for high achievers. Since his school offers 'excellence' versions of the program to high achievers, he now refers to teaching regular Pure Mathematics classes, as 'teaching to the middle'. The Applied, 14/24/ and IOP Mathematics programs were always referred to as being lower level course with low achieving students: those towards the bottom end or the lower end of the ability and achievement range.

Teachers bring expectations, based upon their understanding of the whole range of student abilities and the ways in which the high school course have been designed and implemented to accommodate these abilities, to their classes. All the high school teachers spoke of allocating their teaching time differently for groups of stronger, or weaker, students within each regular mathematics program: spending more, or less, time on explanations and demonstrations of more difficult, or easier, examples. Their perceptions relating to the relative hierarchy of high school mathematics programs influence their attitudes towards and expectations for the particular classes of students whom they teach. In one sense, the middle that they claim to teach to is linked to their perceptions of the hierarchy of mathematics programs. This understanding supports the predominant meaning that that the teachers who say they 'teach to the middle' have for the word middle – a group of students.

A Group of Students

All the teachers identified a large group of students (the middle), within each class, for whom they say their teaching is planned and enacted. This group of students represents "*most of the class*" or "*the majority of the students*"; about twenty-five out of thirty students, or about 70% of a class, and is sandwiched between the groups of "*upper-*" and "*lower- end students*". Although teachers said that the attributes of the 'middle' group vary from class to class (two Pure Math 10 or grade 7 math classes can be quite different in nature) and program to program (teachers described the middle students in Applied and Pure Math classes in somewhat different terms), they echoed Sara's comment that, *"even in a bright class you've got a middle, right? Even with a lower class, you've still got a middle*".

Typically, the middle students' marks cluster around 65% and 50% in Pure Mathematics and Applied Mathematics classes respectively, and are in the 50 - 70% range in junior high mathematics classes. The high school teachers commented that the student composition of this middle group remains consistent, within each course, and as students progress from year to year through their programs. Membership of the

group is predictable, based upon marks achieved in previous a mathematics course. David confirmed that he also finds there is a large group of students, whose marks lie in the 50% – 70% range, but he ascribed this to the type of assessment methods he feels compelled to use, and he refuted any claim that prior marks predict student success. In contrast to the high school teachers, David spoke about the composition of his middle group of students as being fluid. Initially, he assesses that students are in the middle group because they belong to the largest group when he tests learning style; usually these are audio/visual learners. However, each day, students move in and out of this middle group, depending upon how they interact with the tasks and activities he poses.

When the high school teachers spoke of the middle group of students in terms of achievement, it was as if they were talking about teaching a homogeneous group of students. However, their comments revealed that there are a variety of characteristics that they associate with these students. In contrast to the relatively objective nature of their assessment of students' achievement (tests, quizzes and examinations), their assessment of students' characteristics is subjective, formed via their interactions with students, and their interpretation of those interactions. Who asks and who answers questions, the substance of the student's questions and answers, who wrestles with a problem, who waits for guidance, and who uses their time in a judicious manner were all cited as determinants. Martha pointed out that her perceptions and interpretations might be inaccurate because of their subjective nature. Judith recognized that her assessments could be biased, because the students, who respond to her verbal prompts while she is teaching, create them.

Nonetheless, the high school teachers made some observations in common. Some 'middle' students are motivated to work hard in and out of class: they want to be successful. In spite of this, they only manage to achieve average marks. These students have some understanding of procedures, but fail to "*see the big picture*". They can repeat a demonstrated procedure, and some can "*take that knowledge and make it work for them*". Others are unable to extend or apply their knowledge to unusual situations. These students often have many questions, and are dependent upon their teachers for the answers. Steve maintained that the middle group like to be teacher-led, in consistent, routine environments. Sara commented: "*They're not over achievers, not underachievers - they just sort of get it*". While Martha characterized them as "*not quite ready, not quite prepared, not willing to take risks*", and Judith claimed that some middle students

> *have learned how to play the school game, the math game. ...They expect to be told. And their job is to sit and listen and process the information and spit it back. They see that as their role in school.*

Often these students will do only what is necessary to pass the course, '*working to the middle of whatever standard is set*', thus demonstrating a '*desire to be in the middle*'. While these students may have some difficulty understanding the mathematics they are taught, more importantly, they have little interest in working hard, an attribute deemed essential. If the type of tasks they are asked to do challenge this outlook, in quantity, quality or by the route to learning, these middle students can become very negative and may become discipline problems.

In contrast to these descriptions, the characteristics of students, whom David refers to as his middle group, are related to his teaching goals: students' self-confidence, self-esteem, and autonomy, and growth in these areas. When students demonstrate that they are willing to take up a challenge, begin working on tasks, ask themselves and fellow students questions before turning to their teacher, and exhibit a degree of confidence in their abilities. David considers that they are in his middle group: they are blanketed by and benefit from his teaching.

In each case, the teachers compare their students to the ideas they have about the achievement and characteristics of 'good' mathematics students. The high school teachers assess their students according to the goals they have set: to have students work hard, learn what they teach and be able to re-present this learning on tests. Students who do this, by hard work, by playing the school game, or by luck are in the middle group, the group for whom the teaching is planned. When we look at the characterization of students, who are considered to be outside the middle group, the upper-end and lower end students, further light is cast upon 'teaching to the middle'.

The high school teachers spoke about upper-end students, who achieve above average or good marks, even if they receive no special attention. They are ready and willing to engage with the material presented, would benefit from being challenged, can transfer knowledge to new problems, are self-motivated and demonstrate a good work ethic. These students, who apparently would benefit from apposite teaching, are left largely unattended, with the expectation that they will challenge themselves. David's description of upper-end students painted a picture of students who are excited about mathematics, and like a challenge; they were given many avenues to direct their enthusiasms.

David and the high school teachers agree that '*lower-end students*' often meet or have met, with failure, are easily discouraged and needy, will not or cannot complete assignments alone, and seldom request help from the teacher. Steve believes these students *'have made a choice'* not to be successful, because they do not meet his expectations for making an effort to learn and completing their work. David believes he matches his teaching to the learning needs of these students so that that they can be brought into the middle. In David's understanding of the phrase, 'teaching to the middle', he tries to ensure that all students are brought into the sphere of influence of his teaching. The other teachers' meaning more of less ignores the needs of upper and lower end students. This difference speaks again to the divergent understandings of the phrase 'teach to the middle'.

Middle Mathematics

One of the many instructional decisions that teachers make is about the material they will present to students. The high school teachers spoke about teaching mathematics at a level that can be construed as middle – not too hard, not too easy. When teaching, they begin with easier examples and build up to the more difficult questions, guided by the textbook and their perceptions of abilities of the middle group of students in their classes. Later, practice questions from the textbook are assigned for students to work on. The type of questions selected for inclusion, depends upon the teachers' assessment of the ability of the middle group. This approach is typical of the type of teaching the teachers described.

The teachers' comments about the mathematics they teach were framed in the language of the provincial achievement standards and the achievement and diploma examinations. Success on the achievement examination is a central focus.

> *We have to think that our standardized testing, our diploma exams are sort of aimed at 65%, as our supposed class average, or provincial average. And so I think that sort of dictates a lot of what we try to do in the high school mathematics program.*

The high school teachers chose 65% as the goal for their class average mark. With this in mind, they said that select examples and choose assignment questions that reflect the acceptable standard, because the expectation of the provincial standards is that 70% of students should achieve a mark between 50% and 85%. When standard of excellence questions are included in demonstrations or assignments, the teachers highlight them as difficult questions, that few students will be ale to tackle. The decision to work this way reflects a teaching goal: to have students work at and achieve the acceptable standard.

David's approach is different. When he assigns practice questions, he bases his selection upon the responses of students. Some students

> *get fewer questions, but they are the same questions, ... because it takes them twice as long to do them. ... and kids at a higher level have not more questions, but have one more question at a much higher level ... but everybody does everything.*

He is careful to expose all his students to mathematics at the acceptable standard and the standard of excellence.

I sense that it may be argued that, by publishing its expectations and quotas, the province has created an opportunity for teachers to set their achievement goal for students at the acceptable standard. However in Simmt's (1999) study of the teaching practices of Alberta's mathematics teachers whose students performed at a high level on the grade nine achievement test, it was found that the acceptable standard was a launching pad from which to move up and out from, rather than a finishing line: excellence was the expectation and the habit. Setting standards and expectations for students is integral to teaching practice, and reflects teachers' realized personal theories. In one meaning for 'teaching to the middle', the daily experience is learning mathematics at a middle level of difficulty, an expectation and a habit that results in the acceptable standard being a landing, rather than a launching, pad.

Are the teachers' attitudes and beliefs about mathematics, it's teaching and learning, related to their meaning for the phrase 'teach to the middle'?

I attempted to gather information about the teachers' attitudes towards and beliefs about mathematics using a questionnaire, but discovered that this process does not reveal the beliefs that are demonstrated when teachers speak about the teaching decisions they make. Judith, for example, indicated that her personal theory of mathematics (mathematics is fallible, open to revision and correction) is at odds with the view she portrays in school, ("*if you follow a procedure you inevitably come to the correct answer*") as if the mathematics of mathematicians and students is different and therefore should be approached differently. Based upon the teachers' descriptions, it appears that, regardless of any beliefs articulated on the questionnaire,

the high school teachers' philosophies of mathematics are absolutist in nature and reflect Skemp's (1987) definition of instrumental mathematics, in that the teachers have fixed, pre-pared routes to learning mathematics that are directed almost exclusively by the textbook, and which they present to their students. The emphasis is on content, with or without conceptual understanding, and performance, with elements of the research on effective teaching strategies integrated or tagged on.

The roles that the high school teachers describe for themselves and their students are closely aligned with this absolute, and instrumental philosophy of mathematics (Gregg, 1995; Raymond, 1997). Interestingly, Steve used the word 'facilitator' when he described his role in the classroom. He did not use the word in the constructivist sense, meaning 'guide from the side', or even in the sense of 'making easier'. He demonstrated that the word has been taken into 'teacher speak'. Taken from the discourse of teaching reform, it has become a fashionable word (a buzz-word) for teaching actions; it was belied by his interpretations and descriptions of his actions in classrooms. Regardless of the label ascribed to the role of teachers, the high school teachers' descriptions conformed to their inherent philosophies of school mathematics.

David's responses on the questionnaire were predominantly neutral. During our conversation it became clear that he does not subscribe to any one philosophy of mathematics. He described providing learning opportunities that accommodate the variety of learning styles demonstrated by his students. The approaches he uses reflect a variety of philosophies. He finds that some students learn certain concepts experientially and socially, utilizing logic and reasoning. Other students learn by demonstration and explanation. In David's case, his meaning for 'teaching to the middle' reflects multiple perspectives of the nature of mathematics as well as the roles played by students and teachers in its learning. Here, the nature of mathematics is not central, rather the nature of learning.

Meanings for Teaching to the Middle

A Shared Meaning

When I heard my son's teacher speak the words 'teach to the middle' I felt I knew, instinctively, what he meant. The educators who replied to my survey appeared to respond in a similar way: only two of the returned surveys indicated unfamiliarity with the phrase. From these observations, I have concluded that among mathematics teachers there is a widely-held, general meaning for the phrase that unites those who claim to teach this way, in a community, and separates them from those who critique the practices they associate with the phrase. However, my study has shown that there are at least two distinct meanings for the phrase.

Distinct Meanings

My conversations with the six participants in this study revealed that, although they all claim to teach to the middle', their understanding and interpretation of the phrase is different. In one meaning, the focus is on the teacher and the teaching, which is most often transmissive and constrains students to learn in rules and procedures, in predictable ways. The teaching is planned so that the middle group of students will reach the acceptable standard on achievement tests. However, students, who fall

outside the range of the teachers' influence, do not receive alternative or differentiated instruction. This meaning of 'teaching to the middle' is associated with teaching planned for students whose achievements falls within a broad central range, and whose characteristics and , to some extent, behaviour lie between those associated with stronger and weaker students. In the second meaning, the focus is on the students' learning. By assessing this, the teacher is able to modify and extend his teaching plans to encompass the many ways in which his students learn, so that all students are brought into the sphere of influence of his teaching. This meaning reminds me of the visiting professor, whose words I commented upon in the first chapter. There it is a recognition that the audience or students bring their own understanding and pre-existing knowledge to the environment. The visiting researcher used his perceptions of the understandings of his audience as a starting point, from where his talk radiated, offering space for audience members to organize their knowing.

Among the five high school teachers, there are sufficient areas of common meaning to indicate they share a particular meaning for the phrase, 'teaching to the middle'. Furthermore the commonly held general meaning (as demonstrated on the survey responses) is closely aligned to this meaning. These factors indicate that a 'teaching to the middle' label exists. As such it is powerful. If it is used and its characteristics are recognized, then teachers may chooses to engage in the activities associated with this practice, aware in the moment (Mason, 2001) of their actions, or rework their practices. In either case, the decision is likely to be proactive and decisive rather than a passive continuation of the status quo.

What are the Characteristics of Teachers who 'Teach to the Middle'?

Elsewhere in this study, based upon the responses to my survey, I have written that teachers, who 'teach to the middle' may be found at all levels of schooling across Alberta, and that these teachers have wide ranging educational background and teaching experiences. The teacher participants reflected this miscellany. Despite their differences, each teacher maintained that he or she was trying to meet the needs of as many students as possible in the classroom, and expressed caring and concern for the students whom they teach. At the same time, the teachers were divided in the feelings they revealed about teaching. They reported feeling overwhelmed by their job: some from time to time, others daily. Sara, Judith, Martha and David felt, in varying degrees, unprepared for the demands placed upon them in the current educational and social climate. Judith and Sara speculated that they might leave the profession because of these demands. Diane expressed certainty that her chosen teaching style is appropriate for the students she teaches, yet she revealed her frustration at being unable to motivate many students, a situation she feels has changed over the years she has been teaching. Both Diane and Steve registered their cynicism with the current trends in education, anticipating that "*the pendulum will soon swing back*" to more traditional, transmissive teaching approaches. These concerns, expressed by the teachers, speak to the conditions in which these teachers work (a reason that was offered for 'teaching to the middle', and which I address on page 123) and to the pedagogical challenge that they face.

The Challenge to Pedagogy

At the time of this study, the most pressing issue for the teachers was the implementation of new Alberta Mathematics curricula, which call for reform in the way in which mathematics is taught and learned. The challenges facing teachers, when they attempt to implement reform, have been well documented and the Alberta experience is no exception (McCabe, 2000). The preferred teaching strategies described by the teachers are consistent with the teaching that they have used, and judged satisfactory, under earlier curricula. They said they continue to use these practices because they believe it to be the most effective and efficient way to cover the curriculum in the time available, while reaching the greatest number of students. Nevertheless, they reported trying to find ways to accommodate and integrate the expectations of the curriculum into their existing schemas, because "*Alberta Learning has said this is the way we want it taught and they've incorporated that into their curriculum document ... it's stated now, so its got to be done*".

The high school teachers see the greatest challenge to their pedagogy arising in the Applied Mathematics program, where the textbook and its associated materials place a heavier emphasis on investigative, socially constructed learning, and this pedagogical approach is more difficult to avoid. Their response is to compromise. First, the skills and procedures are taught in the usual traditional way. This includes teaching students how to use the technology associated with the program (the calculators, the computer software and other investigative equipment) by demonstrative 'showing and telling'. Secondly, the projects and investigations are explained and used as culminating activities rather than standalone instruments of learning. However, they encounter problems with this approach. They report that: students do not want to do the activities and/or fail to complete reports; there is insufficient repetitive practice; the activities and projects expect too much from the students, who are characterized as being of low ability, and the type of students in Applied Mathematics classes can not learn this way. Their method of coping, to simplify ('downsize') or reduce the activities to step-by-step procedures, brings the activity into the pedagogic and mathematical 'comfort zone' of the teacher (Stephens, Lovitt, Clarke & Romberg 1989).

Only Sara reported success when using investigations, recognizing that "*everybody gets something out of it*" and that teaching in this way is "*just teaching to everybody*". Still, this type of activity forms a small part of her teaching pedagogical repertoire. Her comments, that she "*hardly taught anything*" and "we'[d] *sort of done it, before I've even taught it*" indicate that although she utilizes the process of investigations, she does not have the pedagogical repertoire to fully integrate a constructivist approach to learning. It seems to her that taking on the role of 'guide on the side' or facilitator, makes her job easier. Once the activity is presented, she stands back, offers suggestions where needed, rather than becoming actively involved in investigating how her students are learning and probing their understanding.

David, too, felt that the teaching reforms challenge his knowledge and skills. He has interpreted the changes as directing him towards more individualized teaching, and individualized educational plans for students. He cannot conceive of a way to achieve this, with the number of students he has in each of his classes. Given his background in special education, and the focus of his teaching, it is not surprising that

he has made this interpretation. He sees two alternatives: teaching the group or teaching the individual. The classroom teaching he described reveals that he maintains a tenuous balance between these two options.

The teachers' stories and comments reveal that they find their pedagogy inadequate for the task they face. Although this is a challenge they associate with the implementation of the new curriculum, their comments reveal that their concerns are longstanding. Their teaching approach either leaves some students outside the influence of their teaching or, as in David's case, leaves him wondering what else he can do to accommodate the needs of individual students. The teachers' language also reveals that while they recognize the limitations of their pedagogy, yet they are not willing or able to change to meet the expectations of a pedagogy they sense is being imposed upon them. In such comments as: "*Alberta Learning has said this is the way we want it taught and they've incorporated that into their curriculum document ... it's stated now, so it's got to be done*", and "*let's not say, "Hey, this is what you should be doing and this is the way to do it", without telling us how it is feasible*" [my emphasis], the use of the underlined pronouns, referring to the curriculum writers, is an indication of the pedagogical divide that they believe exists. This distance is reminiscent of the "two worlds pitfall" (Ebby, 2000, p.70): a space between coursework and fieldwork, pre-service teachers have reported experiencing. At the same time, the teachers value this distance. They say they would like to be told how to teach in a way that would enable all students to learn, yet still ensure that achievement targets are met; a claim that reflects the pervasive nature of the teachers' inherent belief in the conduit metaphor for teaching.) However, they have no confidence that if such an approach exists, it would work in their teaching environments.

Taking the Middle Ground

It is truism to say that teaching is a complex activity, yet it is also a truth. Teachers are surrounded by competing influences and factors, which shape their teaching theories. Not only is a teaching practice or theory developed, in interaction with students, that reflects a teacher's personality and beliefs, but this practice is enacted in a social, political and academic environment. Added to this mix, teachers balance their professional and personal lives. A complex, interpersonal activity, teaching is a risk rich endeavour; justifications for instructional choices are complex, too.

The social and political environment in which teachers work, exerts a influence upon teaching decisions (Anderson, 1998; Ernest, 1988; Borko & Elliot, 1999, Manouchehri & Goodman, 1998). Beginning teachers and those having difficulty implementing new curricula or meeting new expectations for teaching, are strongly influenced by the context of their work place and the advice of colleagues (Hargreaves, 1984 & 1996). The high school teachers said that they work in collegial teams and meet regularly to plan and discuss, among other topics, teaching techniques. These meetings encourage teachers to share ideas and encourage comparable approaches and assessments. Teachers, like Sara and Judith, who are unsure where to 'pitch' their instruction, turn to their colleagues for guidance. Matching their expectations to those of their colleagues was offered as a justification for their teaching decision to teach mathematics at a middle level.

Martha spoke passionately and eloquently about the political climate in which, in her opinion, teachers work. She finds that parents are vociferous in their expectations about the type and rigour of teaching that their children should receive. Based upon the parents' school experiences rather than educational theory or research, they are tightly bound to their expectations for their children's achievement. Martha has found that efforts to introduce new teaching approaches or assessments tools that challenge these expectations, have met with resistance from parents and challenges being presented to her school's administrators. She says she has seen teachers, who have high standards for instruction and challenge their students, confronted with challenges to their teaching. Parental and community expectations for teaching and achievement are instrumental in the evolution of 'politically correct' teaching that Martha called, "*walking the middle ground*".

Tightly woven with parental expectations are those of students. Martha believes that students arrive in high school with their own expectations for the way mathematics teaching should look: teachers, who will provide clear step-by-step explanations and demonstrations, and textbook or worksheet driven, undemanding assignments. Sara has noticed that her Pure Math students wait expectantly for her explanations. Steve commented that students like to be taught this way, to be guided and teacher led. This is a conviction shared with the other high school teachers. He finds that when they are taught this way they say they *like math, like coming to class* and are *not afraid of math.* Students like undertaking activities and investigations, as long as they are explained and straightforward, but do not have it in mind to do the thinking and report writing associated with this type of learning. When challenged to learn 'differently', students react by becoming uncooperative and create a negative atmosphere in the classroom. 'Teaching to the middle' accommodates these students expectations, and, in effect, acts as a class management tool.

A further justification for using the 'teach to the middle' approach was that it is an efficient way to teach. Teachers face a time and workload crunch as they teach, what seems to them to be, a tightly packed curriculum, with limited resources, to large groups of diverse students. Their classes contain students, who are *not quite ready, not quite prepared* for the challenges of the high school mathematics curriculum, and those, who *should not be there* (students whose marks and/or behaviour and attitude indicate an alternative placement, but for social or political reasons have been placed in certain classes). As well, some teachers plan and enact teaching strategies for special needs students in their classes and find this time consuming and distracting from, what they consider is their main focus. The workload, number of classes taught and the large number, and diverse characteristics, of students that teachers interact with each day, results in a time crunch and a justification for 'teaching to the middle'. Although David did not share the high school teachers' instructional strategies, he did offer the same reasons for 'teaching to the middle'.

Teachers develop their own approach to teaching; coordinating their efforts with the expectations of students', parents, society and their peers, while meeting the demands of reaching achievement expectations, special needs students and maintaining personal equilibrium. 'Teaching to the middle', whichever meaning they have, is one solution that the teachers in this study find is the best solution. On the positive side, the 'teaching to the middle' described in this study results in: most

students being successful on diploma and achievement examinations; controlled learning; well managed, well disciplined classrooms, and a workload that teachers can handle. The teachers recognize the limitations of their chosen practice: *"I think most teachers want to push their students, but they know there has to be a reality. They have to come into line with other factors, ... you sort of pick a middle ground and walk that ground*". Using the phase differently, in relation to the challenge he experiences finding numerous, apposite approaches to teaching, David asked "*why can't we just walk a middle ground and say there's not one way that's perfect?*" Only Martha and David spoke the words, middle ground, but I was left with a sense that each teacher had struggled, or is struggling, to find a path along which to walk. They call their chosen path, 'teaching to the middle'.

The many reasons offered by the teachers for their chosen approach to teaching conform with the research findings of Smith III (1996) on teacher efficacy. Teachers teach in ways, within their pedagogical repertoire, they that find are most effective for students, in light of past teaching successes. There is a strong causal relationship between a teacher's sense of efficacy and student learning. Teachers who experience a low sense of efficacy tend "to attribute students failures to factors beyond their control – to students' lack of ability, deficient motivation, character flaws or poor home environments.... and maintain more rigid and controlling classrooms" (Smith III, 1996, p.390). Teachers' sense of efficacy is often under assault, from parents, students, administrators and even colleagues. Stress and heavy workload impact a sense of efficacy, negatively. Consequently teachers find it necessary to create a space to work within that feeds their sense of efficacy and allows them to continue in the profession. Smith III suggests that teaching by telling provides the support to efficacy that some teachers find lacking when attempting to implement reform. Many of the justifications offered for 'teaching to the middle' seem to indicate that the teachers have created a space in which to work that in some sense supports their sense of efficacy.

Conclusion

In this chapter I have revealed some of the ways I have come to understand the phrase 'teaching to the middle' as a result of my interactions with the teacher participants in this study. Although each teacher's story is unique, the aggregate impressions formed while listening to their stories, indicate that at least two distinct, but not necessarily shared, meanings for the label 'teaching to the middle' exist. I make this claim because David was aware that at least one other meaning existed. He was concerned about the possible negative connotations associated with 'teaching to the middle' and teaching plans that exclude some students. None of the other teacher participants indicated that they had any awareness that another meaning for the phrase implies working to include rather than exclude groups of students. My examination of the characteristics of teachers who claim to 'teach to the middle' and their reasons for doing so, has yielded an insight into the teachers as well as their meaning for the phrase. In the last chapter I discuss the implications of 'teaching to the middle', as they appear to me, and make suggestions for further research.

CHAPTER XI

Implications and Further Research

The teachers' stories revealed two meanings for 'teaching to the middle'. The meaning shared by the high school teachers is closely aligned to the general perception of this phrase among the mathematics educators who commented upon the phrase on my survey and in general conversation. My findings indicate that the meaning of the sixth teacher is unusual, although not unique. In this chapter, many of the implications I discuss refer predominantly, although not exclusively, to the first meaning.

The Shaping of Teaching Practice

It has been suggested that there are many influences that shape teachers' practices in classrooms (Ernest, 2001; Ross Cornet & McCutcheon, 1992; Simon & Tzur, 1999). One influence that has not been cited by these authors is the power of the mathematics (rather than a particular philosophy of mathematics) to shape teachers' actions. In my study I found that the spectre of the normal probability distribution (the 'bell curve') was a motif that inhabited the teachers' stories of 'teaching to the middle'. The meaning for 'middle' that the teachers explained resonated with this curve. Their assessment of students who fall into this group, their expectations for these students, the levels of mathematics they choose to expose their students to, the hierarchical nature of school mathematics programs, and even their interpretation of which approach to teaching to use all reflect this distribution. Skovsmose (2000) asks the questions, "what is mathematics doing to society? and "can mathematics.... do any harm?" (p.4). An examination of 'teaching to the middle' offers an answer to these questions.

Statistics is a relatively new branch of mathematics: the concept of the normal probability distribution is barely one hundred years old (Johnston, 1999). Based upon the observation that "the measurements of a good many natural and man-made forms – such as height, lung capacity, and manufacturing error – seemed to cluster around particular average values" (Davis, Summara & Luce-Kapler, 2000, p. 106), this distribution predicts the probability of a measurement being close to the average value. It was quickly adopted by the social sciences and the concepts of normal and abnormal were soon applied to children in educational settings.

The teachers' comments in this study reveal the power of the idea of the normal distribution in shaping the teachers' notions and actions about students and teaching. The language they use to speak about the mathematics and the students they teach (middle, average, range, upper and lower end, 70%, within one standard deviation) reveals the degree to which they have absorbed this concept into their instruction. The learning of their students (and by implication the effectiveness of their instruction) is measured by achievement tests provincially and by textbook inspired tests in school examinations. These standards for success or failure have their foundation in the normal distribution, which in turn reflects their value in the society in which we live. Even in classes, where students have been categorized as higher (or lower) achievers, and where the average mark may be higher (or lower), teachers still

perceive a middle and a range of marks that closely matches the bell curve. Teachers, who claim to teach to the middle', shape their instruction to conform to these standards and see the students in their classrooms as a microcosm of the normal distribution.

The normal probability distribution has taken on an entity. It is no longer perceived as a tool, used to measure the probability that a measurement will be close to a mean, but is used to shape the measurement, ensuring that it conforms to the expected probability So, for example, the teachers ensure that their average mark in their Pure Math classes is 65%, in line with the expectations of Alberta Learning, shaping the distribution of the students' marks within the class to the distribution expected for the large population. In an alternative scenario, an assessment instrument would explore students' understandings with the marks landing where they will. In this second scenario, the average mark, and the requirement for comparison to a large population, would have a minor role.

This powerful branch of mathematics is a shaping power in our schools and our society. Teachers refer to the statistic as the goal and the justification for their actions. These teachers shape their instruction to ensure that their students' learning will conform to the normal distribution. Constrained by its power, the teachers express their powerlessness when they claim to be unable to conceive, or enact, instruction that does not 'teach to the middle'.

Examining the meaning that teachers have for 'teaching to the middle' allows me to offer an answer to Skovsmose's questions. Mathematics has provided an mechanism through which human beings may be classified according to artificial notions of normal and abnormal. These classifications support the idea of hierarchy and supremacy rather than equity and democracy. It is clear that perceptions about what average or abnormal students should be able to accomplish permeate educational thinking, and 'teaching to the middle' in particular. The teachers' descriptions of the characteristics of many of their students, supports the impression that this way of thinking about students is not useful and indeed may be detrimental. Further research might consider this perspective by investigating the impact of 'teaching to the middle' upon students and commenting critically upon the formatting power of mathematics, within our schools.

A Teaching Challenge

Teaching groups of individuals

A recurring theme that peppered the teaching stories was the issue of one teacher being responsible for teaching large classes of diverse students. The challenge to teachers is to address the needs of the individual within the group setting, while ensuring that the teachers' own needs are not overwhelmed in the process. Since education became a group activity collected into schools and colleges, students have been grouped according to arbitrary standards related to age and/or ability and achievement, with the expectation that the teacher will be the gatekeeper, providing access to the curricular material. Teachers, who 'teach to the middle' respond to this challenge by further sorting students, whose needs are judged to be sufficiently in common, into groups. These groups seldom take physical form, but are the rational focus of their teaching plans. In an alternative view the teacher perceives all students

as individuals, with distinct learning needs: it then becomes necessary to plan for each student, individually. This is the direction that David feels himself being driven towards.

A constructivist approach to teaching attempts to provide an answer to this challenge, in part, by placing individual student's sense-making at the centre of teaching and learning goals, and by structuring the development of meaning, socially, in community with other learners. Many studies that investigate aspects of teaching reveal the difficulties that teachers have adjusting to the realities of teaching under curricula that reflect a constructivist point of view. This study is no exception. The teachers, who 'teach to the middle' report little success with this approach to teaching and learning, and express little confidence that it would result in equal or improved students achievement. However, they admit that the teaching strategies they use, leave some students unchallenged, while others can not seem to learn what they teach. Their pedagogical knowledge is not equal to demands placed upon it by the teaching reforms (NCTM , 2000) that they feel pressured to implement, nor is it adequate to enable them to plan teaching that encompasses all of their students.

I was surprised to discover that some teachers plan their instruction knowing that there will be students who will not be covered by their teaching. Part of teachers' pedagogical knowledge is recognizing what mathematics is easy or difficult to learn, and what strategies most successfully enable learning. Reflecting upon what has worked in the past, may be useful as teacher move forward with their teaching, but it can also shut down teaching possibilities and result in teachers only using methods that they have previously found useful for most students.

The most common meaning for 'teaching to the middle' saw teachers using one approach with all students, regardless of ability, or aptitude. This 'one-size fits all' approach has its basis in the idea that all students can learn in the same way. Historically, this has been through the transmissive approach to teaching, the one favoured by the high school teachers in this study. Undoubtedly there are students who can learn in this way: these students are able to make their own connections, sense and meaning, and then apply this knowledge (Ollerton & Watson, 2001). However, this is only one route to learning, and it may not be an appropriate route for all, or any, students in a particular classroom.

It is tempting to equate 'teaching to the middle' with teaching by telling, but I consider this would be a mistake. Although the high school teachers envisaged teaching to the top 5% of a class or the bottom 10% of a class in terms of modifying the content of their lessons, yet still teaching by telling, it is possible to 'teach to the middle' without telling. Teachers may claim a constructivist approach to teaching yet may still 'teach to the middle' if they constrain students' learning into particular paths of sense making, such a step by step activities that lead to only one solution (Gregoire, 1999) or routinized investigations. Using the buzz-words of the teaching reform movement does not rule out 'teaching to the middle'; neither does teaching by telling imply 'teaching to the middle'. Rather, the teaching actions that constrain and limit the possibilities for students to an arbitrary middle range are those associated with 'teaching to the middle'.

Further research that considers the dilemma of teaching individuals in groups would be useful. The latter is intrinsically tied to the normative ideas outlined in the

first part of this chapter; the former to post modernism. Teachers are reminded, daily, of the unique nature of the individuals they teach, and are challenged to bridge the divide between these two perspectives. It may be informative to look at teachers who do not claim to 'teach to the middle', to see how their meaning and interpretations of similar situations is different from those who do claim to teach this way, and how they resolve the group/individual dilemma.

Creating Students to Teach

The high school teachers claim that 'teaching to the middle' is their response to meeting the needs of most of the students in their classes bears examination. From their descriptions of middle students, one can infer that these students need: to be teacher-led; routine; external mathematical authority - explanations demonstrations and examples to refer to; piecemeal mathematics that leads up to problem-solving, and external support, discipline and motivation. These students would like to experience success and a sense of accomplishment, yet the teachers' comments indicate that the middle and lower-end students seldom experience either. The picture created is one of students who are passive learners, receivers of knowledge, dependent upon their teachers (this dependency was one reason offered by teachers for failure to implement teaching reforms), and is far removed from the image of students portrayed in the NCTM Standards (2000), and the Alberta curricula (Alberta Learning, 1996, 1997, 2000 & 2001). The student characteristics ascribed to the middle students are those, which have been associated with the style of teaching these teachers report (Cuban, 1984; Gregg, 1995, & Raymond 1997). Although the teachers complain about and lament these characteristics, it appears that their chosen methods of instruction actually teach students to behave in these ways. One teacher acknowledged that some of these students have learned to play the school game, a game the teachers teach. It is as if the teachers create the middle student to whom they are able to teach, by choosing to 'teach to the middle'. This is a conundrum; for the teachers say that they teach this way because the students can not otherwise learn and still reach acceptable standards, yet, this teaching develops these characteristics and limits the students' exposure to challenging mathematics.

Predicting success

When we teach, we ultimately reap what we sow. I have claimed that 'teaching to the middle' creates student who fit the teachers' perception of middle students. Now, I make the claim that 'teaching to the middle' restricts students' access to challenging mathematics and limits the potential of their learning. The teachers in this study have interpreted and integrated the achievement standards into their teaching: the examples that they demonstrate and the questions that are assigned for students to work on are chosen with a focus on students achieving the acceptable standard. (One teacher said that her goal was to bring as many students as possible to the acceptable standard.) The degree of infiltration of these provincial achievement standards is evidenced by the way teachers spoke about the mathematics they teach in their classrooms. They did not mention the topics of mathematics (patterning, ratio, constancy, exponential growth and so on) or specific illustrations of mathematical

ideas or even skills. Instead the focus of their comments was on the level or standard of the questions and investigations they use in their classrooms.

The teachers rely upon their textbook and various Alberta Learning documents for direction in setting their classroom standards at a middle level. They choose not to emphasize more challenging mathematics, unless they are teaching 'gifted' or excellence classes. When classes appear to have a greater number of less able students, they gradually build up to examples at the acceptable standard. Research undertaken in England where student also take part in high stake testing (Boaler, 1989 & 1997), indicates that students, even those classified as low ability, performed better on national examinations, when exposed to challenging mathematics, if they were given the opportunity to explore mathematics in the context of their own pre-existing knowledge and connections, and in community with other learners. In a similar way, Simmt's (1999) teaching practices study associated exposure to challenging mathematics in the classroom with higher than average results on grade nine achievement examinations. The interpretation of 'teaching to the middle' offered by five of the six teachers in this study appears to encourage and predict students' achievement at a middle level. Further research that investigates the connection between 'teaching to the middle' and achievement standards would be useful to support or contradict my claim that this practice limits potential student achievement.

Teachers' Assessments of Students

One critical component of 'teaching to the middle' is assigning students into groups. The high school teachers reported that they identify the middle, upper- and lower-end groups of students by the marks these students bring with them from previous mathematics classes. The only ongoing methods of assessing achievement that the teachers made reference to were: in school unit tests, quizzes and achievement examinations. Teachers indicated that the in-school instruments were modeled on the provincial achievement tests, which comprise multiple choice, numerical response (short answer) and written response questions. These types of assessment are used more for measuring the closeness of students' achievement to the average, than for revealing students' meaning and conceptual successes and difficulties. Since the teachers find that students tend to stay in the group, throughout the year and from year to year, this method of placement is self-fulfilling, and this perspective is justified by and justifies their normative expectations.

The teachers formed their impressions of the characteristics of students in the groups through informal, interpersonal assessments. The quality of these varied from teacher to teacher. Some teachers told stories that revealed a close connection with their students, others maintained a more distance relationship. For the high school teachers, these characteristics were the result of the students being categorized as middle students, rather than indicators that students belong in a particular group. This type of informal assessment is nearly always perceived in relation to the teacher's expectations for a particular student or group of students, and "tends to change only if it is not possible to explain later behaviour in a way that is consistent with [earlier] impressions" (Morgan & Watson, 2002, p.92). Since teachers, who 'teach to the middle', claim to frame their instruction with the needs of the middle students, further research should investigate the ways in which these teachers arrive at

their formal and informal assessments of students. Research of this type would reveal the interpretative nature of the teachers' assessments, the role it plays in teachers' planning and the impact upon the students.

Conclusion

Very little is straightforward in educational matters; the 'teaching to the middle' phenomenon has proven to be no exception. In one sense each teacher's path through the influences and expectations that shape his or her teaching practice is unique: each has his or her own story. In spite of this, some teachers do identify what they do as 'teaching to the middle', expecting that others, who make the same claim, will share some common experiences. The stories I heard indicate that the phenomenon is multifaceted and has implications for many aspects of teaching and learning. I have attempted to capture the essence of the phenomenon by suggesting two meanings that teachers have for the phrase and by examining the characteristics of six teachers who say that they teach this way, and their justifications for doing so.

I understand that my study is the first one that has taken 'teaching to the middle' as its focus. It has been my intention to write stories and interpretations that resonate with those who read it. Just as I have interpreted the teachers' stories within my own unique set of experiences, so will my readers. The power of the study is in this resonance. If it resonates with lived experience of those who read it, then the possibility exists for 'in-the-moment' awareness of actions, and the potential for change.

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APPENDIX A

Descriptions of Student Performance

Alberta Learning has produced Standards Documents for high school teachers of Pure Math 10, 20 30 and Applied Mathematics 10, 20, 30, to assist teachers in understanding the student performance required to meet the provincial standards. (Alberta Learning, 2000). A description of the standards and students' abilities and achievements precedes a section of exemplars of work at the acceptable and excellence standards. Although the information given in the following pages relates to Pure Math 10, similar documents exist for Pure 20 and 30 and Applied 10, 20 & 30. These may be viewed on the World Wide Web:
http://www.learning.gov.ab.ca/k_12/curriculum/bySubject/math/

STANDARDS FOR PURE MATHEMATICS 10

The content specified in the program of studies for Pure Mathematics 10 contains the knowledge, skills and attitudes that all students are expected to acquire. As well, there are specific outcomes for problem solving and the use of technology. For complete details of the Pure Mathematics 10 course structure, refer to the program of studies.

Pure Mathematics 10 is designed to follow directly from Grade 9 Mathematics, so students taking Pure Mathematics 10 are presumed to have reached the acceptable standard or better in the outcomes of Grade 9 Mathematics. In particular, students will have facility in using the scientific calculator; have an ability to add, subtract and multiply polynomials; have an understanding of the Pythagorean theorem and the three primary trigonometric ratios; and have an ability to produce estimated lines of best fit for bivariate data.

The assessment standards for Pure Mathematics 10 include an acceptable and an excellent level of performance. Student performance should be measured on a range of tasks, some of which are routine and obvious tasks in familiar contexts, and others which are nonroutine tasks in unfamiliar contexts.

Acceptable Standard

The *acceptable standard* of achievement in Pure Mathematics 10 is met by students who receive a course mark between and including 50 per cent and 79 per cent. Typically, these students have gained new skills and a basic knowledge of the concepts and procedures relative to the general and specific outcomes defined in the Pure Mathematics 10 program of studies. These students can apply this knowledge to a limited range of familiar problem contexts.

Standard of Excellence

The *standard of excellence* for achievement in Pure Mathematics 10 is met by students who receive a course mark at or above 80 per cent. Typically, these students have gained a breadth and depth of knowledge regarding the concepts and procedures, as well as the ability to apply this knowledge to a broad range of familiar and unfamiliar problem contexts. This standard signifies high-quality performance relative to the general and specific outcomes in the Pure Mathematics 10 program of studies.

Description of Standards

The following statements describe what is expected of Pure Mathematics 10 students who meet the *acceptable standard* or the *standard of excellence* on independent work. The statements represent the standards against which student achievement is measured.

Acceptable Standard	***Standard of Excellence***
Students who meet the *acceptable standard* in Pure Mathematics 10 consistently perform acceptable work on routine and obvious tasks in familiar contexts.	Students who meet the *standard of excellence* in Pure Mathematics 10 consistently perform excellent work on routine and obvious tasks in familiar contexts, and acceptable work on nonroutine tasks in unfamiliar contexts.

These students have a basic understanding of the concepts and procedures outlined in the program of studies. They demonstrate their understanding in concrete, pictorial and symbolic modes, and can translate from one mode to another. They perform the mathematical operations and procedures that are fundamental to pure mathematics at the 10 level, and apply what they know in daily living contexts.

These students have a comprehensive understanding of the concepts and procedures outlined in the program of studies. They demonstrate their understanding in concrete, pictorial and symbolic modes, and can translate from one mode to another. They perform the mathematical operations and procedures that are fundamental to pure mathematics at the 10 level, apply what they know in daily living contexts, and provide alternative solution procedures to verify results.

To meet the *acceptable standard*, students communicate about mathematical situations in an understandable way, using appropriate everyday and mathematical terms. They understand mathematical questions containing objects, diagrams or numbers in familiar contexts; and they construct mathematical models.

To meet the *standard of excellence*, students communicate about mathematical situations in a clear way, using numbers, diagrams and appropriate mathematical terms. They understand mathematical questions containing objects, diagrams or numbers in familiar and unfamiliar contexts; and they construct mathematical models by translating words into suitable numbers, diagrams, tables, equations and variables.

Students meeting the *acceptable standard* apply what they know in solving straightforward problems in familiar settings and in analyzing simple mathematical models. They describe the steps they used to solve a particular problem, and verify and defend their solution to the problem.

Students meeting the *standard of excellence* apply what they know in solving routine and nonroutine problems in a broad range of settings. They describe the steps they used to solve a particular problem; defend their solution to the problem; and, where appropriate, provide alternative solution procedures to verify results.

Students meeting the *acceptable standard* have a positive attitude toward mathematics and a sense of personal competence in using mathematics. They demonstrate confidence when using common mathematical procedures and when applying problem-solving strategies in familiar settings.

Students meeting the *standard of excellence* have a positive attitude toward mathematics and show confidence in using mathematics meaningfully. They are self-motivated risk takers who persevere when solving novel problems. They take initiative in trying new methods and are creative in their approach to problem-solving.

General and Specific Outcomes
General Outcome Generalize operations on polynomials to include rational expressions. **Specific Outcome** 2.1 Factor polynomial expressions of the form $ax^2 + bx + c$, and $a^2x^2 - b^2y^2$. [E]

[C] Communication [PS] Problem Solving
[CN] Connections [R] Reasoning
[E] Estimation and Mental Mathematics [T] Technology
[V] Visualization

Notes:

- Expressions of the form $x^2 + bx + c$ were factored in Grade 9 Mathematics.
- Students must be able to factor expressions such as $ax^2 + bx - c$, $a \neq 1$ and $a^2x^2 - b^2y^2$.
- Included are expressions such as $af^2 + bf + c$, where f is itself a monomial like x^2
- Two variable polynomials, such as $ax^2 + bxy + cy^2$, are not part of this specific outcome
- Students should not spend time on quadratics where the product ac has many factors.

Descriptions of Student Performance (Related to Specific Outcome)	
A student demonstrating the *acceptable standard* can: • identify monomial common factors • factor expressions like $ax^2 + bx + c\ (a \neq 1)$ and $a^2x^2 - b^2y^2$.	**A student demonstrating the *standard of excellence* can also:** • factor expressions that require the identification of monomial common factors • factor expressions like, $f^2 - g^2$, $a^2f^2 - g^2$ and $af^2 + bf + c$, where f and g are monomials.

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General and Specific Outcomes
General Outcome Analyze the numerical data in a table for trends, patterns and interrelationships. **Specific Outcome** 1.2 Use words and algebraic expressions to describe the data and the interrelationships in a given table with rows that are related recursively (calculated from previous data). [C, CN]

Sample Task

[✓] Conceptual
[ ] Procedural
[ ] Problem-solving

Question:

1. The following table contains information about a loan.

Year	Opening Balance	Interest Rate %	Interest Charged	Annual Payment	Closing Balance
1	$20 000.00	5	$1000.00	$4619.50	$16 380.50
2	$16 380.50	5	$819.03	$4619.50	$12 580.03
3	$12 580.03	5	$629.00	$4619.50	$8 589.53
4	$8 589.53	5	$429.48	$4619.50	$4 399.51
5	$4 399.51	5	$219.98	$4619.50	$0.00

a. How long is the term of the loan?
b. What is the total interest for the term?
c. Describe how the bank calculated the amounts in the last three columns for Year 1 of the table.

Solution:

1. a. The term is 5 years.
b. The total interest is $3097.49.
c. Interest charged = opening balance × 0.05

$$\text{Annual payment} = \frac{\text{amount borrowed + total interest}}{5}$$

Closing balance = opening balance + interest charged − annual payment

Descriptions of Student Performance (Related to Sample Task)	
A student demonstrating the *acceptable standard* can:	**A student demonstrating the *standard of excellence* can also:**
• interpret the table to correctly determine the term of the loan and the total interest • provide descriptions of how to determine the interest charged and the closing balance for Year 1 of the table.	• provide a complete description of how all values for the last three columns in Year 1 were determined.

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Appendix B

Alberta Initiative for School Improvement.

Late in 1999, the Albert Government approved funding for this program whose "goal is to improve student learning and performance by fostering initiatives which reflect the unique needs and circumstances within school jurisdictions". It is recognized that school improvement is a long-term goal that may be achieved through the sustained collaboration and commitment of stakeholders. School that choose to participate in the initiative receive funds from the Government The success of projects is measured by improvement in student scores on the Albert Achievement Tests in grade 3, 6, and 9, and on the Diploma Examinations. Further in formation and a list of all AISI projects may be found at http://www.learning.gov.ab.ca/k_12/special/aisi/default.asp

UNIVERSITY OF ALBERTA

Dear _____,

Thank you for completing the survey at the recent MCATA conference in Red Deer, and for volunteering to participate in my research into the expression "teach to the middle".

Before we meet for the interview, which I anticipate will be about an hour long, please complete the enclosed questionnaire, which should take about twenty minutes, and return it, together with the completed research consent form, to me in the envelope provided. Your responses will be used as a starting point for our conversation during the interview.

Once I have interpreted the responses from the survey, the questionnaire and the interview, I will invite you to respond to my interpretation of your comments. This collected and interpreted data will be reported in my thesis. It may also be used for professional journals, and presentations to teachers. The data will be used and stored confidentially, protecting your identity with the use of a pseudonym, while maintaining your character. All information will be destroyed when my research is completed: I anticipate that this will occur by March 30, 2001.

If you have any questions about the study, concerns about your participation, or if you wish to withdraw from the study, please contact *Susan Ratti Dept. of Secondary Education, 341 Education South, Edmonton, AB T6G 2G5 (780 - 492-0881) or sratti@ualberta.ca.*

Thank you for taking the time to participate in this study. Your input in valuable and appreciated.

Sincerely,

Susan Ratti

UNIVERSITY OF ALBERTA

Research Consent form for Use with Adults.

I, _____, hereby

consent to be

- ☐ Interviewed
- ☐ Tape recorded (check each box, as appropriate)

By Susan Ratti

I understand that:

- ☐ I may withdraw from the research, without penalty, at any time until your identity has been removed from the data
- ☐ All information gathers will be treated confidentially and discussed only with your supervisor
- ☐ Any information that identifies me will be destroyed upon completion of this research
- ☐ I will not be identifiable in any document resulting from the research.

I also understand that the results of this research will be used only in the following:

- ☐ Research thesis
- ☐ Presentations and written articles for other educators.

_____

(Signature)

_____

(Date signed)

APPENDIX D

Questionnaire

Please read each question and then circle one response: strongly disagree (SD); disagree (D);neutral (N); agree (A); strongly agree (SA). The responses from this questionnaire will be used during the interview.

1. Mathematics is mainly concerned with getting a finished product, the right answer	SD D N A SA
2. The process of achieving an answer is more important than the right answer.	SD D N A SA
3. Mathematics creativity is not a part of school mathematics.	SD D N A SA
4. School mathematics should be connected to everyday life.	SD D N A SA
5. Students must be shown how to do mathematics.	SD D N A SA
6. It is more important to learn the rules than to understand them.	SD D N A SA
7. Students can create their own mathematics knowledge.	SD D N A SA
8. Mathematics is mainly about problem-solving.	SD D N A SA
9. Mathematics is fallible, open to revision and conjecture.	SD D N A SA
10. Mathematics is fixed and bounded.	SD D N A SD
11. The goal of mathematics teaching is to have students learn and then repeat mathematical knowledge.	SD D N A SA
12. Repetition is necessary to be able to understand mathematics	SD D N A SA
13. Mathematics is like a game with rules to be learned.	SD D N A SA
14. The teacher's role is assign lessons to students and explain the rules and procedures.	SD D N A SA
15. The student's role is to learn what the teacher presents.	SD D N A SA
16. Almost all students can learn to think mathematically.	SD D N A SA
17. The student's role is to explore, question and investigate.	SD D N A SA
18. Students need a quiet peaceful environment to learn mathematics.	.SD D N A SA
19. It is important to learn the basics before you tackle problems.	SD D N A SA
20. The way I teach is very much like to way I was taught mathematics.	SD D N A SA
21. The curriculum influences the way I teach.	SD D N A SA
22. The textbook has an important influence upon what and how I teach.	SA D N A SA
23. My teaching is similar to that of other mathematics teachers in my school.	SD D N A SA
24. I often meet with colleagues to discuss mathematics teaching	SD D N A SA
25. There are societal pressures (parents, administration, financial, achievement examinations, etc.)that influence the way I teach.	SD D N A SA
26. There is seldom a reason to use additional resources to supplement the textbook	SD D N A SA
27. Technology is an important, everyday tool in mathematics classrooms.	SD D N A SA

28. School mathematics is primarily procedural. SD D N A SA
29. My lessons follow the same format each day. SD D N A SA
30. It is necessary to have a solid understanding of mathematics before you can teach it. SD D N A SA

Based upon your current mathematics teaching assignment, please indicate how much emphasis you place on the following activities:

	No emphasis	Little emphasis	Much emphasis
Teacher centred, large group discussions	_____	_____	_____
Student projects	_____	_____	_____
Computer based activities	_____	_____	_____
Guest speakers	_____	_____	_____
Small group work	_____	_____	_____
Paired work	_____	_____	_____
Individual seat work	_____	_____	_____
Use of concrete materials	_____	_____	_____
Other (please specify)	_____	_____	_____

Thank you for completing this questionnaire. Please use the space below to provide an additional comment or information.

Please return this questionnaire in the enclosed envelope to: Susan Ratti, Dept. of Secondary Education, 341 Education South, Edmonton Albert T6G 2G5